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ABSTRACT

Herein are discussed the relaticnship of Brunerian methodology to teacher training models; some attempts to implement Bruner's model of the relationship of school tasks to cognitive levels, grade placement of material, inquiry learning, motivation, and audiovisual efforts; and the preparation of teachers for the new curricula, including instituting the new curricula, preparing teachers to teach the new curricula, and preparing teachers of teachers for the new curricula. (Editor)

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Preparing Teachers to Teach Brunerian Curricula

by

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Preface

Jerome Bruner's book, The Process of Education, ushered in a decade of enormous activity in education. To summarize the implications for teacher education of such a decade is a large and difficult task.

This task was done in an all too short period of two months. To accomplish it required the help of others which must be acknowledged. I would like to thank Mrs. Ann Padilla who searched Dissertation Abstracts for titles. Much thanks must also go to Robert Denby of the Eric Clearinghouse for English for locating the many Research in Education titles used in this report. Finally, the efforts of Miss Jane Williams must be recognized. Her work with the card catalog and Education Index was most helpful as was her assistance in preparing the manuscript.

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INTRODUCTION

Progressive education ground to a halt in the early 50's as more and more people became disenchanted. The voices of the disenchanted were many; some were shrill; some were reasonable; and some were unreasoning, but they all had their say. One of the shillist voices was that of Arthur Bestor who dubbed the educational establishment as "regressive (p. 43)." Bestor's primary concern was with the goals of education. He acknowledged pedagogy as a legitimate, but applied field. As he saw it, the proper concern of pedagogy was how something might be taught; not what should be taught. The what, or goals of education were the concern of the academic community with which he identified.

A great deal of heat was added to the situation by Soviet success in space. The rocket that launched Sputnik I also launched the National Defense Education Act (NDEA) with an assist from Admiral Hyman Rickover. Rickover successfully argued that the security of the United States was threatened by the failures of its schools to produce technologically qualified persons in large numbers. Numerous

comparisons of the numbers of mathematicians, physicists, chemists, and engineers prepared each year in the Soviet Union and in the United States were made. Because the Soviets exceeded the Americans in these comparisons the common schools were found wanting. The view that existence as a nation depended upon improvement of our schools prevailed. The NDEA act was easily passed by Congress to stimulate education in technical fields, foreign languages, and counseling.

Conant examined the high schools of the United States and found them wanting. Conant applauded the American invention of the comprehensive high school, but he was less enthusiastic about what able American youth studied in the comprehensive high school. He called for highly academic, discipline oriented programs of study for able youth whom he felt should go on to college. The pronouncements of Bestor, Rickover, Conant, and many others either created or reflected a public opinion that called for fundamental changes in American schools.

Meanwhile, others were at work establishing patterns that change would take. Among those were Jerrold Zacharias, Max Beberman, and Edward Begle (Abraham, p. 218), all of whom were at work even before Sputnik. Collectively these men, and many others, felt that the content of the common schools was badly in need of modernization and that inquiry

Procedures should replace lecture, assignment, and drill as teaching techniques.

The task of relating public disillusionment with the schools to innovative curriculum procedures fell to Jerome S. Bruner. Bruner, Zacharias, Begle, and 32 other key educators met at Woods Hole in 1959 to discuss how education in science might be improved. A systhesis of those discussions was produced by Bruner in the form of a slim book entitled, The Process of Education. Process set the pattern of change for one of the most dynamic periods ever experienced by public education.

In Process, Bruner identified four themes that emerged during the Woods Hole discussions. The themes were: the importance of structure in learning, readiness as a function of approach, the importance of intuition, and the value of intrinsic motivation. The use of audio-visual materials as a source of vicarious experience was also discussed.

Structure was seen as important because it facilitated non-specific transfer of learning, that is, learning how to learn within a field of inquiry. Bruner saw the transfer phenomenon as central to education. Children were to be taught to make appropriate responses in a wide variety of situations. As they saw it it was not possible to teach children how to relate in every specific situation that might be encountered. Thus the best that could be hoped for

was to teach a central core of generalized responses that could be adapted to the requirements of particular situations. To be useful learners must understand the principles upon which generalized responses are based. Because most situations cannot be anticipated even at a general level, learners need to know strategies of learning, that is, how to reason within a field of inquiry.

The term structure referred to a fundamental set of principles that were seen as facilitating understanding of events not yet encountered. Structural principles were conceptualized as being interrelated and together with an appropriate mode of inquiry constituted a field of inquiry or a discipline. It was theorized that a learner with a well articulated sense of structure would be better able to grasp new situations involving the structuring principles which provided an intellectual framework. New material, being merely specific instances of already understood general principles, would add to one's understanding of the structuring principles. A sense of structure was seen as giving learners cognitive maps for intellectual roads as yet untraveled.

Bruner called for a reexamination of learning readiness in terms of structure. To qualify as structure, a principle must be so basic and pervasive as to be useful in simple concrete instances as well as complex abstract instances.

Very young learners should be able to learn the principle at some level of sophistication, perhaps only at an intuitive level and with reference to concrete events. To be worth learning the principle should be helpful in allowing more mature learners to deal with more complex situations, as well as being of value to the pupil at the time of learning. This line of reasoning constitutes the rationale of Bruner's famous assertion, "that the foundations of any subject may be taught to anybody at any age in some form (p. 12)."

Bruner as others before him, visualized curriculum in terms of a spiral. In spiral curricula pupils encounter the same ideas in more sophisticated forms through the school years. Bruner's spiral, of course, was made of structural principles. The structural elements were embedded in specific contexts ordered in complexity by cognitive levels as enunciated by Piaget. Bruner indicated two levels as being of particular relevance to the design of school curricula. One was the stage of concrete operations which included activities requiring the learner to obtain data from the real would and transforming it in such a way that it can be used selectively in the solution of problems. The other was the stage of formal operation. Learners functioning at the formal level were not bound by what they have experienced. They could deal effectively with abstractions and hypotheses.

In Bruner's spiral, learners would repeatedly encounter structural principles in contexts sequenced according to Piaget's formulation of conceptual levels.

The advantage of structural knowledge lay in usefulness in dealing with novel events. To relate novel events to relevant structuring principles required insight. Insight was seen as the product of intuitive reasoning. Intuitive reasoning is non-rigorous and when compared to analytic thinking--disorderly. It is also subject to error. Not all perceived relationships prove to be true when tested. Learners must be prepared to make mistakes and to realize that error is an ordinary biproduct of creative thought.

Bruner was especially interested in heuristic procedures. Heuristic procedures were conceptualized as non-rigorous reasoning strategies that employ intuition. Bruner gave reasoning by analogy, appeal to symmetry, examinations of limiting cases, and use of visualizations or models as illustrations of heuristic reasoning strategies. No claim was made that the use of these strategies would always produce correct solutions, but these strategies often produced novel and creative solutions. Further, it was hoped that facility with heuristics prepared learners to reason through more complex problems independently, that is independent of schools and grades.

Motivation for learning was the fourth theme developed by Bruner in Process. The concerns here was with learner preoccupation with affairs of the peer culture and academic "spectatorites." Bruner also wished to avoid something he dubbed "meritocracy": excessive stress on grades and test performance. He saw this leading to a new elite as job opportunities became tied to school performance. The desire was to make education intrinsically motivating; school learners were to share the thrill of inquiry and discovery experienced by research scholars. Motivation for learning the spiral curriculum was to be natural curiosity and involvement of the learner in the processes of inquiry.

The final chapter dealt with audio-visual materials and devices as aides to implementing curricula with the proposed characteristics. Here again, there was concern for spectatorites which was associated with so many filmed presentations. Bruner's plea was for audio-visual materials that could be integrated into the fabric of the curricula for which they were designed.

Science experiments were seen as classical audio-visual devices, but not if they were merely watched. Experiments with pre-ordained outcomes were not seen as useful either. Experiments should arouse learner curiosity, provide experience and data for problem solving, and exercise structural knowledge. Films were seen as important sources of vicarious

knowledge or data when integrated into the fabric of instruction. Novels and dramatic films were also seen as devices to present important ideas and relationships. Finally teaching machines were endorsed for their usefulness in teaching and to relieve teachers of some of their more tedious tasks.

In Process, Bruner struck four themes. He stressed the importance of structure, which can be defined as an interlocking set of ideas, principles, concepts, etc. and an appropriate method of inquiry. Next, he stressed the importance of readiness which he visualized as levels of cognition after Piaget and he gave special attention to two levels: concrete and formal. Intuitive thinking was endorsed as being similar to the kind of reasoning used by scholars during inquiry. Finally, the importance of intrinsic motivation was stressed. Learners should find joy in learning if they are to persist past the awarding of the final grade in a course. He closed with a short statement on audio-visual instruction which he saw as valuable when it facilitated inquiry.

Little is said in Process about the preparation of teachers. We can make some inferences however from what was said about curriculum and learning. First of all, in order to teach curricula built on Bruner's model teachers would have to be well informed in the discipline(s) they are teaching. Teachers cannot teach a knowledge of structure they

themselves do not possess. Since structural knowledge requires more than a group of the specifics in a text we infer that he meant that teachers should be thoroughly prepared in subjects they teach.

We also infer a necessity for a rather thorough knowledge and understanding of developmental psychology, especially Piaget's levels of cognition. Rather obviously teachers would also have to understand the behavioral cues associated with levels of cognition. Thus, teachers would have to be clinicians as well as scholars.

As Bruner points out, analytical thinking is rule bound and produces fairly predictable results. Intuitive thinking is not and does not. To teach Brunerian curricula, teachers will also have to be skilled inquirers and skilled in helping others inquire.

Finally, teachers will have to be enthusiastic about learning an inquiry if they are to model the behavior desired under "Motives for Learning." If inquiry is not perceived as rewarding for the teachers, why would children wish to become inquirers?

In the decade that has past much work has been done with Bruner's concepts of curriculum and instruction. Some of that work will be reviewed in this paper. The paper is divided into two parts. Part one deals with studies that in some way evaluate Bruner's four theme conceptualizations.

In part two studies dealing with attempts to prepare teachers to use curricula developed on the Bruner model will be reviewed.

Part I

Some Attempts to Implement

Bruner's Model of Curriculum and Instruction

Discipline Structures

Bruner's articularion of the conclusions of the Woods Hole Conference touched off numerous attempts to define the structure of various disciplines, some of which will be summarized in this section. The references dealt with under this heading are grouped by general subject: English, mathematics, science, and social studies.

Structured Approaches to English

Conceptual Studies. Several approaches to the structuring of English were suggested. Steinberg, Cottrell, Slack, and Josephs described an approach which included literature, composition, and language studies. Language study appeared to deal with those topics which were formerly the concern of grammar and usage. Carlsen and Crow examined the same three part structural approach and found it wanting in some respects but commendable in others.

Finally, two alternate and less complete formulations of structure for literature were suggested. Huff's central concern seemed to be the sequencing for instruction of pieces of literature in order to build conceptual structures. Sanborn was more concerned with communication in a social context.

Steinberg, Cottrell, Slack, and Josephs (1966) described an inductive approach to the teaching of English including

literature, composition, and language. The instructional patterns recommended appeared to be similar to Suchman's in that a stimulus--bit of literature, idea from a reading, or a sentence--is presented along with a structuring question, e.g., what is the tone of this poem?, what events in the story support this interpretation?, or how is this word functioning in this sentence, and discussion issues. Inductive teachers were described as having a series of questions regarding the stimulus which tend to guide the learner's discovery of the goal relationships. While the authors quote Bruner and Piaget for their psychological rationale, what they recommended was almost programmatic. One might be able to explain their strategy as well with a conditioning framework. The authors cite a number of advantages for the inductive approach including: pupils' practice in speaking and listening, the occurrence of open-ended questions that cut across all subdivisions of English, and the opportunity for artistic expression in teaching. A number of specific examples of content and lessons were presented, but no data were presented to support major assertions.

Carlsen and Crow (1967) reviewed materials produced by the various Project English Centers. They found several universally accepted characteristics. English was seen as consisting of language, literature, and composition; English was to be studied as a discipline for its own sake rather than for utilitarian reasons; and inductive methods were

stressed. Carlsen and Crow felt that the centers had succeeded in writing materials from a consistent point of view for the first time. They observed that chronological and biographical approaches were all but dead. NDEA institutes were seen as the "line" functions of the centers; the curriculum projects were seen as performing "staff" functions. They were disappointed in not finding any new ideas, rather they found elaborations of pre-existing ideas. Age grouping was also accepted, but English as communication was not. They regretted the absence of skills programs and noted that the public expects English teachers to teach spelling and other basic skills. A number of other exceptions were noted. Carlsen and Crow singled out the Florida project for praise in that they were seen as having attemped to evaluate their program. They closed by noting that each professional generation seems to start out fresh without capitalizing on what has already been learned.

In a conceptual study, Huff (1968) saw the acquiring of enabling or strategic concepts as necessary to reading imaginative literature. He viewed models of concept learning as providing an approach to sequencing a literature curriculum. In sequencing, one would begin with an illustration of a basic concept that has utility in developing a structure or conceptual net. The acquired structure would serve to facilitate the discovery of other structures which interlock at

some level of abstraction. Huff saw the organizing of literature by structures as making literature more comprehensible.

Sanborn (1967) viewed language as a process which proceeds through inquiry to develop conceptual structures. He considered two orders of language process: the processes by which cognitive and linguistic competence is developed and the regular structural and operational principles through which such processes acquire form in a social context. In this scheme, a language event is seen as having the constituents of speaker, person addressed, message, and context. Sanborn's approach to English would place man and his efforts to communicate in the center and metaphorizing, explicating, role-taking, and interpreting would receive emphasis as primary unifying features.

Empirical Studies. Two studies contrasted groups taught traditionally with groups taught through structured approaches. Sullivan, Okada, and Niedermeyer found a structured approach successful in teaching composition skills to primary children. Blake and Hammill were also concerned with composition, but were less successful in a comparison study of intermediate pupils.

Sullivan, Okada, and Niedermeyer (1971) used a carefully sequenced set of exercises to teach 420 first-graders story writing skills. The 64 exercises were taught over the five and one-half months. They began with tasks which required pupils to select responses appropriate to a pictured situation and ended with tasks requiring the students to

construct their own responses. The criterion task was a story written about a stimulus picture. The pictures were judged by an elementary teacher, a high school teacher, a writer of children's stories, and an editor. Correlation between readers was .76. Pupils receiving the experimental program significantly outperformed a comparable group of uninstructed pupils in terms of total number of words used, number of sentences used, and by making fewer errors of capitalization and punctuation, and spelling errors. The investigators concluded that the use of systematic materials can improve the story-writing proficiency of first-grade children.

Blake and Hammill (1967) compared compositions written by two classes of fourth and fifth-grade pupils taught structural linguistics and two taught conventionally. A pre-post design was used. The criterion task was performance in writing an essay which was graded for a number of specific characteristics. No reliability figures for grading were reported. Groups had comparable socio-economic backgrounds and verbal abilities. The experimental group was found to use a signigicantly larger vocabulary. All other contrasts were non-significant. More non-significant positive changes were found for the experimental group, however. The authors concluded that the results of the study encouraged the teachers in this sample to continue the program.

Summary. Structured approaches to the teaching of English were formulated and tested. The formulations usually included three content elements: literature, composition, and language or grammar. According to Carlsen and Crow the approaches faithfully articulated a point of view. That point of view stressed inductive methods and English as a discipline to be studied for its own sake. Those conducting empirical studies found some support for these formulations.

Structured Approaches to Mathematics

Structure received attention in mathematics also. Buchalter surveyed 45 common school mathematics texts and found that they dealt with lower cognitive aspects of mathematics structure more adequately than higher cognitive processes. Dyer unsuccessfully sought to demonstrate the superiority of a structural approach to the teaching of reliability. Finally, Kaprelian reports a pilot study of the Patterns in Arithmetic program.

Buchalter (1969) developed an instrument to assess the structural content of mathematics textbooks. She defined structure in terms of the following concepts: sets, ordered sets, groups, fields, vector space, and logic and foundations. Her instrument was also designed to assess the cognitive levels with which concepts were dealt. A panel of 15 judges used the instrument to evaluate 19 series which included a total of 45 texts. She found that the structural concepts were better covered at lower cognitive levels, that

application was not handled better than knowledge and comprehension, and that the presentation of mathematical structure at the two lowest cognitive levels did not differ from presentations of higher cognitive processes. Buchalter concluded that the texts examined dealt with mathematical structure inadequately.

Dyer (1969) compared learner achievement and transfer from a lesson on reliability presented in three modes. The modes were: diagram, verbal, and non-review. A no-instruction control group was also used. She hypothesized that the diagram presentation would result in greater learning because it graphically depicted structural components of the lessons. The verbal treatment contained the same content as the diagram treatment, but the three-level structure was not depicted. The non-review group merely read the 7000 word passage that the experimental lessons were based upon. No significant differences were found between groups on either the achievement or transfer task. Dyer identified some problems with her materials and suggested that these problems might be responsible for the result of no significant differences.

Kaprelian (1961) reported results of an evaluation of the pilot program of Patterns in Arithmetic (PIA). He found that 92.3% of the fourth-grade pupils receiving PIA instruction reported favorable acceptance. They also reported that

they had been especially helped in division, multiplication, and prose tasks. Sixty-three per cent reported that the program helped them very much but interestingly 55% stated they needed help from their teachers more with PIA. All in all, PIA was well received by the pupils during its fourth-grade pilot run.

From these few studies little can be concluded. Bruner's ideas were tried and found popular, at least in the form taken by the Patterns in Arithmetic.

Structured Approaches to Science

Science received as much attention as did any of the instructional fields during the Brunerian decade of curriculum reform. Here we will rely on Gong to give us a general picture of these curricula. A short description of a particular elementary science curriculum which will be the subject of a number of studies is presented by Mayor and Livermore.

Gong (1964) used Berelson's technique of content analysis to "expose" the assumptions, rationale, and questions of the new secondary school science curriculum projects in terms of their goals, content, organization, instructional procedures, and teacher education. Under goals he found a general assumption that an understanding of the theoretical framework of modern science, and not its practical or personal-social applications, as the most valuable outcome to be

achieved. The content of the new science curricula was found to consist of theoretical knowledge of the kind that might interest research scientists. The content was seen as separate from its own historical development, other school subjects, and from related technology. The new courses were organized to link content with methods of inquiry. The dominant strategy was to engage pupils in a planned sequence of repeated encounters with scientific inquiry related to major concepts and theories of the discipline. The favored instructional scheme was found to be a procedure that imitates the behavior of research scientists. Teacher education was seen as a five-year process emphasizing scientific concepts and inquiry processes basic to the modern state of the discipline. Work in methods of teaching science was also recommended.

Mayor and Livermore (1969) described Science--A Process Approach, an integrated mathematics, science, and social science curriculum for grades K-7. The curriculum was made up of grade level "parts" and each part contains 20-25 exercises ordered by process hierarchies. Behavioral objectives and criterion tests were produced, tested, and revised.

Two investigators were unsuccessful in demonstrating the superiority of structural approaches to science over conventional or random organizations. Dallas contrasted a hierarchial with a non-hierarchial approach and Pyatte compared a structured to a random approach.

Dallas (1968) compared application learning of two groups of science education students taught ten science concepts organized, or not organized into a hierarchy. A no-instruction control group was also used. The criterion was an examination of applications as defined by Bloom. The examination was validated by a jury of professional scientists and educators. No significant differences between treatment groups was found, but highly significant differences between treatment groups and the no-treatment control group was found.

Pyatte (1968) sought to test the effects of a structured presentation dealing with measurement on achievement and transfer learning. A carefully-sequenced programmed text was prepared along with a random version of the same text. Fourth, fifth, and sixth-grade pupils in three schools studied the texts and took the achievement and transfer tests. For the analysis of the data, pupils were divided into high, medium, and low ability groups based on scores derived from The Iowa Test of Basic Skills. Pyatte found no significant differences for mode of presentation. Significant differences were found for grade and ability group. Brighter pupils did better with the organized program.

From Gong's analysis we conclude that Bruner's ideas of structure, inquiry, readiness, and motivation were faithfully expressed in new science curricula. The findings of the

empirical studies suggest that instructed groups learn better than uninstructed groups, but that differences in content organization had little effect on outcomes.

Structured Approaches to Social Studies

Conceptual Studies. Bruner's ideas regarding inquiry and structure found adherents in the social sciences. Tucker surveyed the material of the new social studies and found they possessed a number of Brunerian characteristics. Hertzberg described a small teacher-initiated program to develop a structured curriculum for seventh-grade New York history. Anthony criticized authors of new social studies curriculum material for identifying the content to be taught prior to determining the goals to be sought. Elliott surveyed professional literature and concluded that a discipline-oriented curriculum was possible for history. Allen described a program of the Delaware Historical Association to photograph historical documents to give pupils the feel as well as the content of documents used by historians. Finally a critique by Krug (1966) of a structured approach is presented.

Tucker (1969) analyzed and classified dimensions of content and inquiry identified in literature about the "new" social studies. Content questions referred to both the social science disciplines and the practical problems of man

and society. Inquiry questions referred to descriptive and normative problems. She concluded that the new social studies contained multiple dimensions which implied new potentialities for the social studies.

Hertzberg (1963) described an anthropological approach to the teaching of New York State history for seventh-graders developed by a committee of teachers working one evening per week for four years. Details of one of the units (Iroquois Culture) but no evaluative data were presented.

Anthony (1967) criticized the authors of the new history courses as being insensitive to the role of objectives in planning curricula. He maintained that new history authors often decided what should be taught and then figured out the objectives. If pupil needs were taken into consideration micro-analysis would more likely be the stress than the preoccupation with past wars and politics perpetuated by new curricula. Anthony also criticized the stress placed on the use of original sources. He questioned their utility for use with the full range of common school pupils. He felt case studies of the Oliver and Shaver variety might be more appealing and comprehensible to youth.

Elliott (1963) reviewed professional literature to develop a discipline-based curriculum proposal for history. He concluded that it was possible to produce a unified discipline proposal; that it was possible to produce a description of the discipline of history which was inclusive of the main

schools and interpretative approaches; that the discipline proposal could interrelate features of a number of twentieth-century epistemologies and curriculum proposals; and that curriculum workers should take the initiative in carrying through cooperation among scholars and educators.

Allen (1966) maintained that anthologies of primary sources for use in history classes failed to convey the same atmosphere as the original documents. Such anthologies were seen as useful in determining what was said, but were not interesting as artifacts. He described a project of the Historical Society of Delaware which was photographically reproducing small groups of related documents for use in the common schools. A teacher's guide was provided. It was felt that the use of these documents would make the study of history through documents a realer experience.

Krug (1966) questioned the applicability of Bruner's idea of structure to the social studies. He noted the professional historian's disinterest in structure and criticized structuring statements from ESI and the Wisconsin conceptual framework as very general and not especially insightful. He also objected to the amalgamation of several social sciences in the ESI curriculum, Man: A Course of Study. He wondered why no such amalgam was proposed for mathematics and the sciences. Lastly, he criticized structural approaches as stressing the general rather than the specific. Quoting

Bettelheim who expressed a need to understand the complexities and contradictions of mankind he was concerned that pupils might not learn the complexities of the human condition as reported by historians.

The Stanford Studies. One structural approach to the social studies has been underway at Stanford University since 1953 (Williams, 1966). The project had as its goal the production of an articulated K-12 social studies curriculum. During phase I of the project 3,227 basic generalizations were gleaned from literature of the social sciences relevant to ten basic categories of human activities. The selected categories of human activities were:

Organizing and governing

Providing recreation

Protecting and conserving human and natural resources

Expressing religious impulses

Expressing and satisfying esthetic needs and impulses

Transporting people and foods

Producing, exchanging, distributing, and consuming food, clothing, shelter, and other consumer goods and services

Communicating facts, ideas, and feelings

Providing education

Creating tools, technics, and social arrangements

The identified generalizations grouped by the ten categories

of human activities was to constitute the scope of the articulated curriculum.

An expanding communities model was used to sequence the identified generalizations. Eleven "communities" were envisaged starting with "the family community" and ending with "the world community." This survey of research turned up phase II studies dealing with: the school community (Hebler, 1966), the local communities (Parker, 1965), the state community (Del Rosso, 1968), the region-of-state community (Williams, 1966), the national community (LaMarche, 1968), and the emerging Atlantic community (Miller, 1968). Other fragments of the project may have been completed at this time. The third phase of the project is to be an application of the structured social studies content to classroom situations (Hebler, 1966).

The Stanford project was begun long before the publication of Bruner's Process and has its roots more in progressive education than in perceptual cognition. The project is included in this review because it features interlocking sets of generalizations and a spiral organization. Unlike Bruner's conceptualizations, structure here is provided by the ten basic activities around which many discrete generalizations are clustered rather than the same few constructs being taught at more sophisticated levels through the grades.

The model has not been tested nor have classroom materials been produced.

Empirical Studies. Others in the social studies sought to test some aspect of the curriculum development process. Some sought to find strategies for developmental process and product evaluation; others sought to establish the validity of the Brunerian approach. Ehresman worked with agriculture students and teachers with content on farm cooperatives for the pupoose of testing a structured approach. Henzl proposed and tested through action research a scheme for developing a spiral curriculum for the social studies. Gornick contrasted a conceptual approach with a conventional approach and found an advantage for the conceptual approach. Crabtree found significant contrasts for an approach which was pupil paced. Finally, Kurfman developed and tested a scheme for evaluating and revising the products of a curriculum development program.

Ehresman (1967) compared two groups of agriculture students. The teachers of one group had the use of a structured unit; teachers of the second group did not. All groups received instruction on agricultural cooperatives. No significant differences were found in achievement between the two groups. Teachers using the structured unit reported a favorable reaction to its use.

Henzl (1970) proposed and demonstrated a procedure for developing a spiral curriculum in geography. She began by conceptualizing her problem and then proceeded to identify ten basic geography concepts. They were: space, air, time, rock, water, plants, animals, ethnographic man, ecologic man, and economic man. She then prepared a curriculum guide which placed concepts related to space in an ascending order of complexity. Finally, the proposed order of concepts was tested at a number of grade levels to determine their suitability for discovery learning. Henzl felt the procedure had demonstrated its feasibility and recommended continued work on the remaining nine concepts.

Gornick (1968) contrasted performance on an achievement test and on a test of transfer of pupils taught through a conventional approach and through an inquiry-structural approach to elementary school social studies. The content for the experimental group was based on five interrelated concepts derived from economics, geography, history, anthropology, sociology, and political science. The content for the traditional group was derived from ideas contained in a compilation of resource units. The achievement criterion was the Stanford Achievement Test, Intermediate II Social Studies Test; the transfer test was devised by the investigator. No significant differences were found between the groups on the achievement test; highly significant differences

in favor of the experimental group were found on the transfer test. Interestingly, the less able students appeared to benefit most from the inquiry-structured approach. Gornick concluded that achievement was not jeopardized and that transfer was facilitated by the inquiry-structured approach. He also concluded that it was possible to construct a structurally organized curriculum for the social studies and concluded with the observation that extensive inservice training was needed to teach the new approach.

Crabtree (1962) compared the effects of two instructional programs on the thinking of second-grade pupils. One program featured teacher imposed structure, the second was paced in response to pupil cues. Dramatic play and self-initiative activities were used as part of the pupil paced program. The programs dealt with harbors and airports. Both groups were instructed in both programs but in reverse order. The project was conducted over a six-seek period. Point time samples and anecdotal records by teams of independent observers were used as criteria. Very significant results favoring the pupil directed treatment were found on observation of divergent thinking. Similar significance for convergent thinking was found for the teacher controlled treatment.

In conjunction with the development of the High School Geography Report, Kurfman (1969) elaborated a model for evaluating curriculum material. The model provided procedures for the revision of materials, emphasized the

evaluation of classroom experiences and conceptual and skill outcomes, and the use of questionnaires and other sources of information. The model was piloted with the project unit, "The Geography of Cultural Change," with 27 teachers and 1,200 students. Data from application of the model provided explicit prescriptions for revising poorly rated parts of the unit. Geography preparation of teachers was found to be significantly related to learning outcomes with some materials. Sex, grade level, and verbal aptitude of students were related to student attitudes toward the materials.

The problems of curriculum innovation in general received the attention of MacDonald and Abramson. MacDonald argued for a wholistic approach by which he meant examinations of setting variables as well as outcomes. Abramson argued for a continuous monitoring of curriculum products throughout their development.

MacDonald (1971) described some of the problems of evaluating curricular innovation. He rejected the intended outcomes model of curriculum evaluation in favor of a wholistic model which he described as having three basic elements. The first element dealt with the audience for whom the evaluative report was intended. Audiences identified included: curriculum sponsors, local education authorities, schools, and examination boards. The second element was data. He noted that different groups and individuals place different values on the various kinds of data. The evaluator should

supply the intended audience with the kind of data they desire for making decisions and judgements. The third element dealt with the focus of the evaluation, which in this case was wholistic. By wholistic he meant describing the impact of the innovation on the institutions, teachers, and pupils in terms of various problems and antecedent conditions. MacDonald placed a great deal of stress upon descriptions of what occurred and attempts to determine what brought about the occurrences. He was concerned about the particular values, competencies, and interests that motivated teachers of innovative curriculum. He suggested that these conditions created situations where differences in outcomes between schools were greater than differences within the school.

Abramson (1966) argued that curriculum evaluation included more than an assessment of outcomes as is common in so-called wholistic approaches. He argued for a research approach which involved testing each fragment of the program and then testing collections of fragments in operation. Abramson argued for continuous monitoring of curricula during innovation to identify problems as they occur and in time for modification. A simple end-of-project test yields data of concern to the administrator, i.e., should the program be continued, but little data of value to curriculum developers, Abramson asserted. He advocated a generalist role for curriculum researchers to provide "trans-disciplinary" insights to curriculum development.

Summary. While interest in curriculum reform of the kind suggested by Bruner was found in the social studies, it was less universally embraced than in English, mathematics, and science. The criticisms of Anthony and Krug could be matched by others. The Stanford studies suggest at least some interest in alternate models. Studies designed to determine the effectiveness of Brunerian curricula produced mixed results. Of particular interest were the works of MacDonald and Abramson who studied the processes of curriculum development.

School Tasks and Cognitive Levels

A number of studies were conducted to determine the effects of conceptual readiness levels as defined by Bruner and Piaget on accomplishing various school tasks. Muggie studied a group of first-graders and found that many had problems understanding simple social studies concepts. She suggested that it was important for teachers to understand the cognitive level at which pupils were operating. Taba found mixed results when she tested materials designed to develop conceptual levels.

Almy confirmed Piaget's findings for quality and number conceptualization of K-two pupils. Stone found that younger pupils classified objects by perceptual characteristics; older children by function. Cole found difficulty

in dissuading seventh and eighth-grade pupils from irrelevant explanations of bouyancy. Fuller found that pupils operating at the cognitive level of formal operation were better able to infer concept characteristics embedded in meaningful material. Ginsberg found that preschool children learned concepts in simple context better than in more complex context.

Problem solving was the common concern of Delidow and Gunnels. Delidow found differences in inquiry skills by grade level. Gunnels found that the more successful problem solvers operated at higher conceptual levels.

In recognition of the importance of conceptual levels to teachers Solomon produced an assessment instrument which he called "The Taxonomy of Image Provocation Profiles."

Mugge (1968) examined the cognitive processes of a sample of first-grade pupils working with social studies concepts. She found that first-graders had difficulty working with conceptual hierarchies, multiple classifications, and other cognitive processes common to the social studies. She concluded that primary teachers must be aware of stages of cognitive levels and listen carefully to pupils if they are to successfully teach social studies concepts.

Taba (1969) tested three experimental groups and a control group to see whether a social studies curriculum designed to develop cognitive functioning and taught by methods designed to develop cognitive skills would enable

students to learn more complex material earlier. Comparisons were made to groups not experiencing the special curriculum and methods. Results were not consistent, but did tend to support the hypothesis.

Almy (1968) studied the thought processes of children faced with problems involving the concepts of quality and number. She used cross sectional and longitudinal approaches with K-2 children. Both approaches confirmed the relevance of Piaget's theory to the study of young children.

Stone (1968) hypothesized that younger children would group three-dimensional objects by perceptual properties more often than by functional properties. He selected 128 pupils from a school population according to the following criteria: average intelligence, no identified learning or psychological problems, and normal scores on standardized tests. Apparently he sought a population of average primary and intermediate age pupils. The classification tasks were performed individually. His hypotheses were confirmed.

Cole (1969) tested the effectiveness of a two-part audio-visual instructional sequence to teach the concept "specific gravity" to seventh and eighth-grade pupils and college juniors. The first part of the instructional sequence was designed to cause participants to reject four irrelevant principles commonly used to explain floating. The second part was designed to teach the correct principle.

A carefully designed test instrument was developed by the investigator for use as the criterion in this study. Cole found that the instructional program was very successful with the college population, but only moderately successful with the seventh and eighth-graders. The partial treatment, correct principle, was sufficient for the college group, but ineffective for the younger group.

Keller (1969) tested the conceptual ability of a population of 48 sixth-grade pupils half of whom were identified as having attained the formal operation level of conceptualization. Subjects were asked to discover concept characteristics embedded in meaning for material under conditions of high or low feedback. Keller found that pupils at the formal level did indeed conceptualize better.

Ginsberg (1969) conducted three experiments to investigate concept learning and transfer by young children. In each, children were divided into three groups and shown two pictures in which they were supposed to determine which contained more objects. The pictures shown the first group contained only circles; those shown the second group contained similar objects in both pictures; those shown the third group contained unlike objects. When the concept of "more than" had been learned, the children in groups one and two were shown the pictures containing unlike objects. She found that children from the first group had learned most

efficiently, leading her to the conclusion that concept learning was most efficient when the concept was introduced in its simplest context. In each of the three separate experimental samples her results were basically the same. She worked with children varying in age from 38 months to 5½ years.

Delidow (1970) conducted a Piaget-style investigation of the inquiry and conceptual abilities of 293 pupils in kindergarten, second, fifth, eighth, and eleventh-grades. Six inquiry skills were investigated: classifying, observing, predicting, inferring, numerating, and experimenting. He found that younger children favored qualitative classifications whereas older children employed quantitative and evaluative classifications. Prediction was more often used by older, than younger children. Distinct differences in number awareness were found between kindergarten and second grade. Pupils at the operative stage of development could manipulate more than one variable; less mature children could not. Probability was only used by eleventh-grade pupils. Delidow concluded that a definite relationship existed between stages of cognitive growth and levels of inquiry.

Gunnels (1969) studied the inferences made by children from science tests and their relation to Piaget's intuitive, concrete, and formal levels of thinking. Older pupils and those in higher grades used formal levels of operational thought more often in problem solving. In grades 4-9

successful problem solvers operated at a higher level of conceptual thought than the unsuccessful problem solvers with science problems. Gunnels' data agreed that each level of development was prerequisite for the next.

Solomon (1969) developed and tested an instrument to aid teachers in dealing with students of varying levels of cognitive maturity. The levels of cognition were based on Piaget and Bruner and included: concrete, concrete-imagery; representational; and abstract-imagery and abstract levels. The evaluation instrument, "The Taxonomy of Image Provocation Profile," was used at West Virginia University by preservice teachers for self-evaluation.

Collectively these studies support the contention of Bruner and Piaget that readiness is related to developmental conceptual levels. From these data it seems imperative that teachers become aware of conceptual levels, learn the relevant cues, and develop appropriate responses.

Grade Placement of Material

Mindful of Bruner's claim that anything could be taught to any age group at some level of cognition were Eroh, Rupley, Potterfield, and Joyce and Weinberg. Eroh successfully taught concepts of measurement to first-graders. Rupley taught advanced mathematics concepts to upper elementary pupils. Potterfield found pupils in grades four, five, and

six could learn certain anthropological material approximately equally well. Finally Joyce and Weinberg found they could teach basic sociological concepts to third and fifth-graders.

Eroh (1967) structured a sequence of 78 lessons and five review lessons dealing with various concepts of measurement for first-graders. The measurement concepts were: groups of things, money, linear measure, dry measure, household measure, and weight. A control group received unstructured instruction in measurement. She found the group receiving structured instruction significantly superior. Intelligence did not predict success in the program. Eroh concluded that certain measurement concepts could be developed in first-graders, but that does not mean that such concepts should be taught.

Rupley (1967) studied elementary classes taught by a trained mathematician to determine if motivation in school could be developed by interesting pupils in mathematics and to see if the pupils could learn mathematics at a level well above their grade. Both goals were achieved. Success of the motivation goal was judged from the enthusiasm of the pupils; success of the second goal was judged from data reflecting competence with mathematical notions which underlie advanced mathematics.

Potterfield (1968) tested an anthropology unit developed at the University of Georgia with fourth, fifth, and sixth-grade pupils. He found no significant differences in learning

across grades. Fifth and sixth-grade pupils tended to learn more. Interestingly, formal preparation in anthropology by teachers was not related to pupil learning.

Joyce and Weinberg (1964) found that some basic sociological concepts could be taught to third and fifth-grade pupils. Working from a Brunerian point of view they identified several key concepts. They then sought specific cases of each concept observable by elementary school pupils and developed and tested series of questions designed to help pupils observe the desired phenomena. Approximately 180 pupils were seen in groups of 10 to 15. No quantitative data were obtained, but recorded conversations suggested that the pupils learned (or knew) the goal concepts.

These studies lend general support to Bruner's assertion that anything can be taught to anybody at some conceptual level. In the studies reviewed in this subsection, learners acquired facility with measurement, anthropology, sociology, and mathematics long before these topics were encountered in the curricula of the 1950's

Inquiry Learning and Teaching

A central concern of investigators working with Brunerian models of teaching and learning was inquiry. Suchman (1962) formulated a widely accepted formulation of inquiry and conducted an extensive inservice teacher education program with

inquiry methods. His formulation of inquiry process is of interest here.

Suchman conducted a large scale investigation of inquiry training with elementary pupils in science. He defined inquiry as "a way to investigate causation." He conceptualized inquiry as being made up of four distinct stages: searching, data processing, discovery, and verification. The act of searching was defined as a planned and controlled intake of data by an observer. He identified several variables effecting searching including ability, manipulation, perceptual set, and abstract pattern with which to organize data.

The aim of data processing was to reduce information to simpler and more systematic patterns. He identified four types of data processing useful in science inquiry. These included: analysis, comparison, isolation, and repetition.

Discovery, the third stage of Suchman's model, referred to the insightful moment when relationships between parts of the stimuli were perceived or when previously learned patterns were perceived stimulus events. When the inquirer has no way of accounting for a perceived event it may be that he lacks necessary insight or the necessary construct. It was seen as very useful for the inquirer to be given hints or cues helpful in organizing the data at this point. At other times it became necessary for the inquirers to invent new systems.

The final element of Suchman's inquiry model was verification. In verification the inquirer was required to test the perceived relationship with data. The key idea of the program was to place control of the data flow in the hands of the learners. This is in sharp contrast to ordinary didactic methods where teachers sequence the instruction and pupils are essentially passive. Suchman was concerned that passive learners learn only at a verbal level without any real assimilation of the content into their cognitive structures. In inquiry, the autonomy of the learner allowed him to control the flow of information.

Suchman acknowledged that inquiry was more time consuming. Where expository method was adequate for assimilation he observed the rate of learning would probably be much more rapid, the key factor being the teachers' ability to select just those experiences that are most likely to result in the desired understandings.

Suchman sought to increase inquiry behavior of pupils in the classes taught by teachers receiving his inservice program and using his special materials. The usual criterion for studies of inquiry learning and teaching was pupil performance on a transfer task. That is, to what extent could learners, trained in inquiry procedures, apply inquiry techniques, heuristics, or strategies in the solution of novel problems. Incidentally, the term "generations" is sometimes used to denote heuristic when considering rhetoric topics (Young, 1969).

A few investigators sought other outcomes. For example, Hans Anderson (1968) did not succeed in improving the problem solving ability of his subjects, but did find an improved attitude toward problem solving. Anderson, Walberg, and Welch (1969) considered the effects of inquiry processes on classroom social climate.

Anderson, Walberg, and Welch (1969) studied social climates in three classifications of Harvard Project Physics high school classes. The classes were: inexperienced teachers-experimental course, experienced teachers-experimental course, and experienced teachers-regular course. Social climate was measured by the Learning Environment Inventory which included 14 subscales. The population was made up of 3264 high school juniors and seniors in 150 physics classes. Discriminate analysis was used. As hypothesized, highly significant course effects were found. Classes using the experimental course were perceived as less difficult and goal directed, more diverse, and as having a more positive learning environment. Experimental classes had less friction among students and fewer cliques. Significant effects were also found for teacher experience. The social climate in classes of experienced-experimental teachers was perceived as less democratic and intimate and more likely to have social cliques. Classes with experienced-regular teachers and courses were seen as more difficult, goal directed and intimate. The investigators speculated that inexperienced-

experimental classes might be caught in a spirit of cooperative inquiry that disappears when teachers gain experience with the new materials.

A large number of studies were conducted that in one way or another considered the effectiveness of inquiry teaching on some outcome, often achievement and transfer. Generally these studies were of a comparative nature; inquiry was compared to one or more other methods. One method was usually labeled traditional which often meant assignment-lecture-recitation. Occasionally these studies evaluated inquiry procedures against some criterion.

Inquiry Procedures Evaluated

Most of the studies seeking to establish inquiry procedures were of a two group design; inquiry versus traditional instruction, or inquiry versus no instruction. Others compared a group of variables, often two or more inquiry approaches with a no or a traditional instruction control group.

Two Group Comparisons. Beldin compared discovery and conventional methods in four countries and found for the former. Dooley compared inductive and deductive approaches in teaching economics to culturally disadvantaged. Guthrie compared discovery and expository methods in teaching a rule useful in deciphering cryptograms. Mason compared a group taught critical thinking with an uninstructed group.

Showalter compared a child-centered approach with a historic, no instruction control group. Howell compared a group taught effective thinking with an uninstructed group. Ashton compared a heuristic method with a text-demonstration method. Martin compared critical thinking of pupils taught geometry by traditional and "flow proof" methods. Q. C. Smith compared heuristic and traditional approaches by examining student progress in subsequent courses.

Beldin (1969) studied demonstration programs in four countries which compared the discovery method with conventional methods in training adult workers. Overall findings favored the discovery method. Beldin concluded that the discovery method could be used for the specific group, if properly designed.

Dooley (1969) compared the effectiveness of inductive and deductive approaches to teaching economics to culturally disadvantaged children. A pre-post two group design was used. The sample consisted of 484 disadvantaged fourth-grade pupils. The inductive method was found to be "consistently more effective." No indication of the character of the criterion or instruction was presented.

Guthrie (1967) found retention of a rule useful in deciphering cryptograms was improved with expository instruction for college seniors, but that transfer was facilitated by discovery learning. Exposition appeared to impede transfer.

Mason (1967) compared learning and critical thinking of pupils taught by materials developed to foster critical thinking with an uninstructed group. A two group, pre-post design was used. Control groups were taught by teachers who were allowed to adapt the materials to their usual methods. Teachers of the experimental groups taught the materials as intended. He found that all pupils improved in knowledge of science, and all but one grade (5th) improved in critical thinking. Mason concluded that critical thinking can be taught more effectively when students are given direct training in the methods of science.

Showalter (1968) compared children taught by a child-centered approach to an historic traditional group. The Iowa Test of Basic Skills served as the criterion. The child-centered approach featured homogeneous ability groups in the subject area of language arts, mathematics, reading, and work study skills. Classes were taught by teams of teachers and grouping was regularly reviewed. Counseling services were used for the improvement of learning and instruction. Greater growth on the ITBS subtest of vocabulary was found. Questionnaire data found the child-centered approach to be preferred by pupils and their parents.

Howell (1968) compared end-of-treatment scores on the Test of Inference Patterns (TIP) of seventh-grade pupils receiving instruction in effective thinking and uninstructed

pupils. A specially prepared text on effective thinking was used by an inexperienced teacher. Significant differences on total test scores were found. A number of significant subtest differences were also found. No differences were found between sexes. Howell concluded that seventh-graders can profit from instruction in inferrential reasoning.

Ashton (1962) compared a heuristic method of teaching problem solving to ninth-grade algebra pupils with a text-demonstration method. The heuristic method was based on Polya's formulation. Two classes in five schools were used in the study. Gain scores on a problem solving test favored the experimental or heuristic group in each school. Ashton concluded that the heuristic approach was superior.

Martin (1971) compared change scores in critical thinking of tenth-grade pupils of geometry taught proof by the traditional two column method and an experimental "flow proof." The Watson-Glaser Critical Think Appraisal instrument was used as a criterion. Forty-three teachers and over 2000 pupils participated. Teachers using the "flow proof" method were instructed in the method through a handbook prepared by the investigator. No significant differences between treatment groups were found. Questionnaire data suggested teacher approval of the experimental method.

Q. C. Smith (1968) compared two groups of college students receiving traditional or heuristic instruction in

mathematics on performance in subsequent college mathematics courses. He found no significant differences in the performances of the two groups as measured by achievement scores for the two subsequent mathematics courses.

These studies are hard to consider collectively due to variations in definitions of traditional and inquiry procedures, and some deal only with aspects of inquiry. In any event mixed results were produced. Some variation of traditional instruction was found to facilitate retention by Guthrie. Mason found improvements in learning for both traditional and critical thinking groups. Some investigators found support for some variation of inquiry including Mason, Howell, and Ashton. Smith found no sustained effect of an heuristic approach to mathematics in later courses. In a related study Showalter found support for a child-centered approach.

Multiple Comparisons. A number of studies compared some form of inquiry with two or more instructional procedures. Scherpereel compared two structuring schemes with an unstructured approach to the teaching of art history. One structural approach was thought to encourage inquiry. J. S. Price compared two discovery approaches to a text centered program. Petrie compared three inquiry methods and found a teacher modeling approach most effective. McAloon compared various combinations of instruction in logic, mathematics,

and no instruction. Werdelin compared inductive and deductive strategies of teaching principles and fostering retention and transfer. Tanner compared expository, discovery, and unsequenced approaches to the teaching of general science. Finally Roughead and Scandura compared various combinations of rule giving, discovery, and guidance in preparing for a transfer task.

Scherpereel (1967) compared two structural approaches to the teaching of art to an unstructured approach. One structured approach featured contrasts or unalike pairings of art works. The second structured approach featured grouping of works by similarities. The subjects were college students in an art appreciation course. Measures of sophistication, attitudes, meaning, and understanding were obtained. On measures of understanding, both structured approaches exceeded the control group. The contrasts or inquiry treatment group exceeded the similarities group in measures of attitudes and sophistication. Scherpereel concluded that the system of contrasts used in this study promotes inquiry in art appreciation and should be used more widely.

J. S. Price (1966) experimentally compared three programs of general mathematics for tenth-grade pupils. The control group received a traditional text-centered program of instruction. A second group was taught using special "discovery" materials. The third used the discovery materials

and special transfer materials. The groups did equally well on a regular achievement test at the end of the semester. The two experimental groups exceeded the control group on measures of mathematical reasoning and inductive reasoning and had a more positive attitude toward the course.

Petrie (1969) compared the effectiveness of three methods of teaching inquiry skills to university freshmen chemistry students. Achievement tests were given at the end of laboratory sessions and at the end of the semester. Details of criterion tests were not given. She found that teaching method was associated with achievement. Highest achievement was associated with teacher modeling problem solving-structuring behavior when demonstrating laboratory techniques to be learned followed by discourse aimed at conceptualizing the behavior.

McAloon (1969) studied the effects of instruction in logic on the learning of logic and mathematics of third and sixth-grade pupils. Twenty-five teachers and 1100 pupils participated in the study. Four treatments were used: logic and mathematics intertwined, logic and mathematics separately, teacher inservice training, and a no treatment control group. McAloon found that third and sixth-grade pupils can learn logic; that time taken from mathematics to learn logic does not decrease mathematics learning; and that instruction in logic was associated with higher scores in mathematics

reasoning. A number of variations by treatment, grade level, and criterion were found.

Werdelin (1969) studied the effects of various instructional strategies on learning, retention, and transfer. In two experiments Swedish sixth and eighth-grade pupils were taught a mathematical principle and a foreign language alphabet by the following methods: principle followed by examples; examples followed by a statement of the principle then further examples; and examples only. The first method resulted in the best learning of principles while the third method fostered more retention and transfer.

Tanner (1969) studied fourteen ninth-grade general science classes which were taught principles of mechanics and simple machines using one of three methods: expository-deductive; discovery-inductive; and unsequenced-discovery. No significant differences in achievement were found in using the three methods.

In a complex and sophisticated study, Roughead and Scandura (1968) found that naive elementary education women performed a transfer task significantly better if they had not previously learned a rule, either through direct instruction, or direct instruction followed by discovery. All combinations of guided discovery with rule-giving were found superior as was rule-giving after discovery or rule-giving before or after exposition. Roughead and Scandura theorized

that the subjects did not seek new solutions as required by the criterion task if they already knew a solution. Further, it was interesting to note that exposition combined with rule statement functioned as well as discovery procedures. The investigators suggested that it is probably more effective for students to know why they are learning before they learn, than to attempt to tell them after learning has occurred.

These studies are much more complex and therefore harder to summarize. Again the results are mixed. Tanner found no differences in achievement between groups taught by methods labeled exposition, discovery, and unsequenced. J. S. Price and Scherpereel found structured or discovery methods superior to some forms of conventional instruction. Price found no differences between his experimental groups while Scherpereel did. Werdelin found an advantage for a deductive approach as far as achievement was concerned, but a transfer advantage for an inductive approach. Roughead and Scandura found guided discovery to be important under all circumstances.

These studies are consistent with many others. Inquiry-discovery methods generally promote transfer and traditional instruction tends to promote immediate achievement. When inquiry or discovery methods are being used, teacher guidance makes a valuable contribution. Petrie also found it to be important for the teacher to model inquiry behavior when conducting

inquiry teaching. Finally the advantage of instructed groups over uninstructed groups is again replicated.

Comparisons to a Standard. Three investigators evaluated the effectiveness of their treatments in terms of a defined standard. Covington used the Minnesota Test of Creative Thinking as a standard; Constantine--the Watson-Glaser Critical Thinking Appraisal instrument; H. J. Anderson used a stipulated definition.

Covington (1968) tested the effectiveness of a linear instructional program in promoting creative thinking of fifth and sixth-grade pupils. A pre-post, two treatment design was used. Criteria instruments were the Minnesota Test of Creative Thinking and a "modified traditional problem solving test." He found "highly consistent" results favoring the experimental group for immediate post treatment measures. Follow-up data were less consistent.

Constantine (1968) reported on a program of the Illinois Statewide Curriculum Study Center in the Preparation of Secondary School English Teachers (SSCPET). The inservice course sought to train 42 teachers to teach in such a way as to foster critical thinking. Guilford's model of the intellect was used as a basis for studying critical thinking processes. The Watson-Glaser Critical Thinking Appraisal instrument was used as a criterion. Positive, but non-significant results were found.

H. J. Anderson (1968) sought to improve the problem solving ability of a sample of science education students. Seven instructional periods were used. He concluded that the method employed did not improve the problem solving ability of the subjects, but improvement in attitudes toward problem solving was found. Reading ability and critical thinking were found to be related to problem solving as used in this study. There was no relationship found between GPA and problem solving ability.

The pattern of mixed results observed in other studies of inquiry was maintained here. Covington found some positive results, Constantine found only a positive trend, and Anderson found no differences. Further, Covington's follow-up data were less consistent in their support for creative thinking.

Conclusions. From the studies it is difficult to make an unambiguous case for inquiry or discovery learning. It often does seem to produce superior performance on a transfer task and it sometimes promotes retention. Inquiry-discovery approaches are acknowledged to be more time consuming. Traditional or didactic approaches are generally agreed to be less time consuming and to produce superior immediate learning. If didactic learning is meaningful, that is, if the learners can fit it easily into their cognitive structures, traditional teaching produces equivalent results.

Perhaps the situation is best described by Romberg (1969) who characterized recent research in mathematics education as "large in quantity, poor but improving in quality, and diverse (p. 473)." He reported considerable agreement regarding what should be taught but little agreement about how it should be taught. He, like others, noted growing wariness of discovery learning. Comparisons of pupils learning from School Mathematics Study Group (SMSG) materials and conventional materials seemed to indicate that pupils learn what you teach them, e.g., SMSG pupils did better than conventional pupils on a "contemporary" test, but less well on a "conventional" test.

It might be more productive to ask what approach will produce desired results with a particular group of learners possessing specific characteristics than to ask which method is superior. Methods are means to achieve ends and not inherently superior; superiority depends on a number of learner and content variables.

Research Relevant to Aspects of Inquiry

Suchman identified four processes associated with inquiry. They were searching, data processing, discovery, and verification. In this section we grouped studies that appeared to be relevant to one or another of these four processes.

Searching. Suchman identified four variables relevant to search behavior. They were ability, manipulation, perceptual set, and organizational patterns. We will consider each of these in turn.

In this review, ability has been enlarged to include related factors such as interests and personality characteristics. Four studies dealt directly with ability, variously defined. Three of the studies (Wallace, Post, and Dodson) found differences favoring higher ability learners. The fourth study (L. M. Price) found ability unrelated to manipulative search behavior. Price's study will be detailed under manipulation.

Wallace (1969) sought to determine which of several factors were related to a student's ability to solve mathematical problems by the discovery method. Students were freshmen at East Stroudsburg State College. Findings indicated that ability to solve mathematical problems by the discovery method was related to mathematical ability, verbal ability, mathematical achievement, and sex (females were better able to use the discovery method than males).

Post (1969) analyzed students' problem-solving ability to see whether it could be increased by exposure to aspects of a problem-solving process, and to see the relationship between problem-solving ability and intelligence and creativity. Of these factors, only intelligence was found to be significantly related to problem-solving ability.

Dodson (1971) sought to describe "insightful" mathematical problem solvers. The study was designed to make use of the National Longitudinal Study of Mathematics data bank. Aside from superiority in mathematics, Dodson found the following to be characteristic of successful problem solvers: high verbal and general reasoning test scores, good determiners of spatial relationships, resists distractions and identifies critical elements, divergent thinkers, low test anxiety, and positive attitude toward mathematics.

Three studies sought to relate inquiry processes to some individual characteristic. Kersch found individuals to vary in their ability to operate at various cognitive levels by sex, IQ, and socioecomonic status. Wallach found relationships between propensity for risk-taking and behavior of expressing possibilities and analysis. Cunningham found rigidity to adversely effect problem solving.

Kersch (1967) used three methods to ascertain the cognitive levels used by California fifth-grade pupils when considering the basic documents of American government. He used multiple choice questions, pupil interviews, and classroom observations. The data were analyzed by sex, IQ, and socioeconomic status. A number of specific findings were reported. Kersch concluded that boys do better than girls on knowledge and comprehension tasks, but girls out perform boys on higher order cognitive tasks. IQ appeared to be the most important variable related to performance. Socioeconomic

status and performance on knowledge, comprehension, and application questions were related. Kersch recommended that materials should be varied to accomodate differences in sex, socioeconomic status, and ability.

Wallach (1969) considered the differences between "the expression of possibilities" and "the analysis of implications." He suggested that children skilled in the latter but not in the former may avoid risk-taking, innovative activities. Wallach also feared that such educational media as teaching machines might inhibit the process of expressing possibilities and result in an overly rationalistic view of thinking processes in education.

Cunningham (1967) investigated children's rigidity in problem solving. Rigidity was defined as the failure to use objects for the solution of new problems that were used in previous unrelated problems. He found rigidity related to personality, situational factors, previous experience, psychological stress, age, sex, and intelligence. He saw flexibility in problem solving as a learned behavior favored by the use of socratic methods and permissive teaching situations. Students exposed to a variety of problems were able to shift to new problems more smoothly than those who had been drilled on many similar problems.

Clearly inquiry ability is not unidimensional. It does appear to be related to general intelligence, but other factors

seem to be involved. Representative of these other factors are socioeconomic status, sex, and rigidity.

Manipulation. Two studies were found related to manipulation. Price (1969) trained fifth, seventh, and eighth-graders to gather data empirically by manipulating objects with their hands to see whether this process would transfer to a problem situation outside the classroom. Increases in the use of the process in the test situation were not statistically significant, either for gifted children or those of normal range IQ's.

Davis (1964) described two kinds of teaching as important to the Madison curriculum project in mathematics. Experience lessons provided pupils with direct experience with mathematics. Measurement of angles and calibrating a spring balance were given as examples. Teachers were not directly involved in these experiences. Seminar experiences did involve teachers and occurred when pupils had sufficient experience with the mathematics involved to feel the need for some structuring statements. Teachers used guiding rather than leading procedures during seminars.

Neither of these studies provide support for Suchman's notion that manipulation facilitated learning.

Perceptual Set. At least three studies dealt with perceptual set. Grotelueschen manipulated four introductory learning sets in combination with three instructional programs. Slaughter studied pupil interest in relationship to learning,

and John W. Wilson studied three arithmetic problem solving strategies. His conclusions led him to speculate that seeing the structure of a problem might be a function of set. Wilson's study will be detailed under discovery.

Grotelueschen (1968) studied the effectiveness of three instructional programs and four introductory sets. The instructional programs were completely sequenced, partially sequenced, and random. Three of the introductions were relevant to the content, learning base four system of numbers; one introductory program dealt with the theory of measurement. No effects were found for the structuring or introductory materials, perhaps due to their abstractness. Differences were found for the sequenced paired associate learning program. Grotelueschen worked with adult learners.

Slaughter (1965) hypothesized that pupil learning would be related to their interests. Interests were assessed through forced-choice book selections and review of pupil reading lists. The experimental lesson contained equal amounts of biographical and non-biographical information. The introduction was manipulated to stress either the biographical or the non-biographical aspects of the lesson. Slaughter found no significant differences due to introduction. All interest scores were low.

Neither Grotelueschen nor Slaughter found their data to support the contention that perceptual set effects learning.

John W. Wilson thought that set might influence perception in solving a problem.

Organizational Patterns. Two studies dealt directly with organizational patterns. James Wilson taught pupils general and specific heuristics; Henry encouraged learners to invent their own categories when classifying pieces of literature.

James Wilson (1968) studied the effects of instruction in task specific, means-ends, and planning heuristics on problem solving and transfer tasks. Instruction was given through self-instruction booklets to 144 high school pupils. Problem solving achievement tended to be independent of level of the heuristic in which the pupils were instructed. Significant interactions were found for the transfer tasks. Problem solving was enhanced by knowledge of a combination of heuristics and by practice in their use. Wilson concluded that means-ends heuristics and planning heuristics should be incorporated into problem solving instruction.

Henry (1968) described a unit approach to the teaching of literature that stressed concept development. The goal of the approach was to encourage pupils to invent the unit's structure rather than to learn the teacher's structure as is commonly the case with unit instruction. Pieces of literature were presented serially. Each piece was read for its esthetic value. A discussion then ensued to decide whether the

new piece was an instance of the category under consideration or an instance of a new category. Henry noted that complexity could be added by random presentation of pieces of literature. The program was tried with 10 teachers and 400 pupils. High pupil involvement was reported.

Summary. Collectively these studies do not support Suchman's formulation of searching behavior. There were differences in inquiry outcomes for learners of varying intellectual and personal characteristics. Set, manipulation, and organizational patterns did not seem to have noticable effects on inquiry. No final judgement can be rendered because little work appears to have been done.

Data Processing. Several studies considered ways in which learners process data. Larsons, Byers, and Geisinger studied strategies used by learners in solving problems. D. W. Chambers and Kersh discussed results suggesting the value of practice in organizing data. The value of practice also found support from Johnson and from James Wilson (see Searching--Organizational Patterns). J. K. Davis examined the effect of cognitive style on concept identification and found analytic subjects to be particularly effective. Finally, two studies contained an element of learner control over the inquiry process. Johns used self-pacing and Iventasch self-direction. Henry in the previous section encouraged learners to invent the structures they used in categorizing literary events.

Larsons (1965) compared fifth-graders experienced in inquiry with inexperienced inquirers on two of Bruner's and two of Piaget's cognitive problems. Problems were administered individually to the 36 pupil subjects. She found three strategies being employed: focusing, scanning, and specific. There were no differences in the strategies employed by pupils when working the problems of Bruner and Piaget. The pupils most experienced with inquiry were the most sophisticated problem solvers, but the next most experienced group was the least. Larsons concluded that the four components of strategies--objectives, organization, system, and validation--could provide useful dimensions of future studies.

Byers (1961) developed a procedure to determine information gathering strategies used by two samples of educational psychology students to gather information during a concept learning task. The task consisted of learning two characteristic concepts embedded in a field of five irrelevant dimensions. Instances of the concept were presented on three-by-three cards arranged in rows and columns before the subjects. The order of card selection was recorded and became the record of the subject's information gathering strategy. Time-to-criterion was the dependent variable. The procedure did succeed in identifying subject information gathering strategies. Both groups used a full range of strategies

that varied from low risk, conservative focusing to high risk, focus gambling. The optimal strategy, conservative focusing was seldom used, but subjects did improve with practice.

Geisinger (1965) sought to teach tenth-grade pupils a restraint strategy useful in solving Twenty Questions problems. One group was taught the strategy, another was not. Both groups learned equally well leading the investigator to conclude that an opportunity only was required to learn the strategy.

D. W. Chambers (1971) conducted an experimental study which compared four levels of discovery and two levels of overlearning using an achievement criterion. Chambers was careful to differentiate discovery and guided discovery from meaningful learning, discovery teaching, and inquiry teaching. He found overlearning to have a more powerful effect on transfer than did discovery. Overlearning seemed to be an important condition for transfer of a discovered principle because practice seemed to make the discovered principle available for transfer.

Kersch (1962) found support for the conclusion that self-discovery motivated high school pupils to practice and thus remember and transfer more than groups taught directly. In other results, rote and guided discovery groups performed equally well on recall and transfer tasks on post and several delayed post treatment tests.

In a study designed to improve problem solving processes Johnson asked groups of college students to write solutions to problems with the following results: instructions to write many solutions resulted in solutions of lower mean quality but more superior solutions; quality was raised by information about criteria for good solutions; and large quantity was associated with low quality.

J. K. Davis (1969) conducted two experiments to study the influence of an individual's cognitive style on concept identification. In the first study high school students classified figural patterns into four categories. Results showed that high analytic subjects made fewer errors than lower analytic subjects. In the second experiment four different training conditions were used (verbal-prompt, prompt, verbal, and control) with different groups of the students. Again high analytic subjects made fewer errors than lower analytic subjects. Training procedures did not differentially effect performance of subjects with different cognitive styles.

Johns (1966) compared eighth-grade science pupils instructed by traditional means and by means of a self-paced series of experiences. Commercial measures of critical thinking, problem solving, attitudes, study skills, and subject content were used as criteria. Five teacher-made tests were also used. Johns found no significant differences

between groups on the commercial tests. Significance in favor of the traditional group was found on three of the teacher-made tests.

Iventasch (1969) found no significant differences between teacher-directed and self-directed problem solving techniques in their influence on content achievement, understanding of concepts for problem solving, and attitudes of the junior high school students tested.

Learners were found to use a variety of strategies in processing data for problem solving. Byers found that they seldom used the most productive strategy. Johnson found that quality of solutions improved when subjects learned the characteristics of superior solutions. Larsons found her most experienced inquirers were her best inquirers. Practice in using inquiry strategies was also found to be important by Chambers, Kersh, and Wilson (in the previous section). Davis found inquirers with personal analytic styles most effective in concept learning from figural patterns. Interestingly, Davis' training procedures did not effect learner performance. Neither Johns or Iventasch found an advantage for pupil control of learning processes.

From these studies it appears that learners use strategies in organizing data. It appears that strategies can be taught and that practice with a strategy improves performance.

Discovery. The act of discovery was defined by Suchman in terms of insight or the perception of relationships among elements of the problem. While insight happens within individuals, teachers can facilitate its occurrence by arranging or sequencing events and by asking structuring questions. Discovery will be considered under two headings: Conditions and Teacher Manipulations.

Conditions. A few investigators addressed themselves to considerations that could be classified as conditions promoting inquiry. Marin considered the effect of closed versus open-ended experiments. Buckeye (1969) found that creative ability and achievement levels obtained by preservice mathematics teachers were increased by creative college classroom environments. Baughman developed a set of criteria with which to evaluate the value of materials in promoting heuristic thinking. Marin (1969) studied the effects of open-ended experiments versus closely directed experiments on concept comprehension, laboratory performance, and achievement in problem solving in high school physics. No significant differences were found.

Baughman (1968) developed criteria for materials that promote heuristic thinking. His procedure was to determine the cognitive tasks--as defined by Bloom--required to conduct heuristic thinking as described by Polya. He identified criteria for materials that promote heuristic thinking: the situation must be based upon an important structural idea, the situation must provide elements to create information

not anticipated by pupil experiences, the situation must contain the unknown element embodied in an unknown process or idea, the situation must contain minimal data, and the situation must be based on a search for a pattern or condition.

Teacher Manipulations. A number of teacher manipulations are thought to encourage discovery. Among these are questioning strategies, cues, and highlighting. Two investigators looked at teacher questions. Pfeiffer and Davis examined the cognitive levels of questions asked by teachers on examinations. John W. Wilson examined the characteristics of problems stressed by arithmetic teachers in problem solving. The effects of guidance on problem solving was studied by Butts and Jones, and Salstrom. Frick used the number of cues used by learners as an indication of learner intuitiveness. Highlighting in the form of having learners verbalize correct solutions to concept learning tasks was used by McNeany and Keislar.

Pfeiffer and Davis (1968) classified questions on teacher made ninth-grade tests according to cognitive levels as described by Bloom. A variety of junior high school subjects were involved. Contrasts were made by curricula: college preparatory, business, and prevocational. While more higher order questions were found for pupils in college preparatory courses, an overall lack of concern for the areas of analysis, synthesis, and evaluation was found. More higher

order questions were found for English and world history than for other subjects.

John W. Wilson (1965) experimentally compared three arithmetic problem solving programs. One program stressed action-sequence structures; i.e., it attended to characteristic actions and sequences of each operation. The second program stressed "wanted-given" structures; i.e., the characteristic purposes of each operation. The third program was a practice-only control group. The subject population was made up of 80 fourth-grade pupils randomly assigned to treatment by ability third. All contrasts were significant and each favored the "wanted-given" program. Wilson speculated that "seeing" a problem's structure might be a function of an acquired set rather than the result of organizing a field. He also speculated that the structuring definitions and phrases might actually be functioning as mediating variables.

Butts and Jones (1967) studied the effects of planned guidance on the problem solving behavior of elementary pupils. Pupils assigned to the experimental treatment received inquiry training from 30 to 60 minutes per day for three weeks. A pre-post design was used. A specially constructed inventory of science processes was used as the criterion. They found a significant relationship between inquiry training and problem solving behavior, but no significant relationship with concept transfer or changes in recall of factual knowledge.

Salstrom (1967) compared two science inquiry strategies differing in the amount of guidance afforded sixth-grade pupils. The 130 pupils were given decks of cards relevant to an observed science event. Questions the pupils might wish to ask were printed on one side of the cards; answers on the other. Pupils were asked to select those cards bearing questions they wanted to ask and to arrange the cards in the order in which they wanted them asked. Salstrom found significant differences favoring the group receiving greater guidance.

Frick (1969) sought to establish a relationship between intuitive thinking and achievement, creativity, and certain socioeconomic factors. The Westcott Perceptual Inference Scale was used to identify intuitive thinkers. The scale is made up of 15 figures. Eight clues are given for each figure. Pupils identifying figures with few clues were classified as more intuitive than pupils who used more clues before making an identification. The population of 96 Illinois fifth-graders was found to be skewed toward the non-intuitive end of the scale. Correlations of intuitive thinking scores with measures of achievement, socioeconomic status, and creativity were found to be non-significant.

McNeany and Keislar (1967) studied the effect of labeling on problem solving of kindergarten children. The problem solving task was to select the correct picture of three differing in size only. Some pupils were required to verbalize

the correct selection, others were not. In a pilot study, significant differences were found for the labeling group. These results were not replicated in a more elaborate study where presentations were electronically controlled. There was some indication of interfering effects of language.

Summary. Not enough work was done with conditions that promote discovery. Baughman did establish criteria useful in developing or evaluating materials designed to promote heuristic thinking. Marin did not find open-ended science experiments superior in teaching concepts, laboratory performance, and problem solving.

A fundamental teacher manipulation is questioning. One would presume that inquiry teachers would use more higher order questions. Pfeiffer and Davis found that teachers ask a disproportionate share of lower cognitive questions. We presume that little inquiry was being conducted. Butts and Jones were successful in teaching an inquiry process and Wilson found a wanted-given strategy superior for mathematics problem solving. Guidance during problem solving was found to be important by Salstrom. Apparently pupils can be taught to inquire and some specific teacher manipulations were found to be productive.

Motivation

Motivation does not seem to have received the same degree of attention as other facets of Bruner's formulation. It certainly received less attention than problem solving and inquiry. No claim can be made that the few studies reported here represent the entire body of research. We can simply say that we cast a broad net and came up with few studies.

While they are few in number they are not without interest. Only one study directly tested the proposition that intrinsic motivation was superior to extrinsic motivation. That study was conducted by Boyle. McGuire and Rowland considered the role of curiosity in basic learning processes. They considered an understanding of curiosity essential to understanding basic intellectual processes. Two studies brought out the individual nature of motivation. Diamond surveyed eleventh-grade pupils to determine their motivation for enrolling in chemistry. Hardin surveyed intermediate and junior high school science pupils and their teachers to determine which aspects of a science course were most interesting.

Relevance was considered by two investigators. Conklin identified two theoretical positions regarding relevance and Schneider advocated the use of locally developed materials to achieve relevance.

Two studies not directly related to Bruner's formulation of motivation are included because they are interesting and describe alternate approaches. Ohme's is the first. He described an elective short course organization that offered both pupils and teachers greater opportunity to capitalize on their particular interests and talents. The second is Koch who described a self-paced contract approach to U. S. history.

Boyle (1964) compared the effects of intrinsic and extrinsic motivation on learning and retention. Ninety sixth-grade pupils were grouped by treatment--extrinsic, intrinsic, and extrinsic-intrinsic--and ability--above or below 115 IQ. Pupils read a four-page article and were immediately tested. They were tested again in two weeks on the same content. Boyle found no differences for the conditions of extrinsic or intrinsic motivation, but significant differences on both the immediate and delayed posttests for the combination treatment of intrinsic-extrinsic motivation.

McGuire and Rowland (1968) reviewed Berylne's work on curiosity. Motivation, exploratory behavior, epistemic, and selected factors such as arousal were studied. McGuire and Rowland concluded that a knowledge of the effective use of curiosity is necessary for understanding intellectual processes.

Diamond (1971) studied relationships between reported motivation for enrolling in eleventh-grade chemistry and understanding of basic chemistry and problem solving. She also examined the effectiveness of chemistry curricula in promoting science understanding and considered the need for alternate chemistry curricula. She obtained information from 684 pupils regarding their reasons for enrolling in chemistry and certain demographic data. She also obtained measures of basic chemical knowledge and problem solving, understanding of science, and intelligence. From intercorrelations she concluded that a majority of pupils elected chemistry for reasons other than preprofessional, that traditional curricula were more successful than CHEM curriculum for highly motivated preprofessional pupils, and that intelligence and reason for studying chemistry were the best predictors of performance on the American Chemical Society examination. She concluded by calling for additional curricula in chemistry to better meet the needs of the full range of eleventh-graders.

Bruner held that pupils learning from structured materials and inquiry methods would be intrinsically motivated. Hardin (1964) surveyed 867 intermediate and ninth-grade Florida science pupils and their 32 teachers. Two inventories--one for pupils and one for teachers--were used. Through factor analysis Hardin found the following. Pupils were interested in manipulation of physical science materials,

class participation, speculation about the earth and a number of other items. Science interests of the two age groups were well defined and different. Pupil involvement in classroom science experiences according to pupils was related to a supportive classroom climate, use of pupil experiences in class, expressions of teacher concern for pupils' personal problems, and participation in field trips. Pupil involvement according to teachers was related to application of research methods, participation in scientific inquiry, acquisition of basal background information, and a number of other factors. Hardin also found pupils more discriminating about teacher-pupil relations than instructional methods used.

Conklin (1968) approached the problem of motivation through the concept of relevance. He saw every philosophical system as viewing relevance either as intrinsic; that is, relevance exists a priori and is discovered; or as created by human action and stipulated convention. He went on to discuss the implications of the concept of relevance to various educational and philosophical relationships.

Schneider (1969) called for locally developed materials as the best way of obtaining relevant curriculum materials. He argued that America is a large and diverse land and that a curriculum suitable for one section, residential group, or ability level might not be suitable for other groups. He described a program carried out in New Jersey where four

introductory units to a two year required U. S. history course were developed. The units utilized case studies, local problems, protest music, and other materials all selected in terms of relevance to a specific population of pupils. He reported success in motivating pupils. The materials were well received by average and less than average pupils, but superior pupils wanted to get on with preparation for College Boards and other conventional preoccupations of the academically oriented. The materials were also judged successful in their basic goal, supplying a reason for studying U. S. history. Schneider noted that time, funds, and moral support were supplied by the school district and observed that without such support the job cannot be done. He also noted the possibility of school districts serving similar pupils banning together to their mutual advantage.

Ohme (1970) described an interest centered curriculum developed and tested at Torrance, California. The school year was divided into four nine-week quarters. Each quarter a number of short courses developed by teachers were taught. Pupils were free to select courses without regard to grade level; grades 10-12 were involved. Stress was placed on designing "relevant" courses. Ohme claims that relevance was achieved in that pupils selected that which interested them from a wide variety of choices and teachers taught that which was relevant to themselves. He noted that popular

management innovations such as flexible scheduling and team teaching became more relevant with an interest curriculum. He also noted that teachers judged less adequate became highly visible.

Koch (1968) described a process oriented U. S. history class that he taught. The approach used included contract study, independent study, and a combination approach. Pupils worked independently on agreed-upon learning tasks or upon learning tasks devised by themselves. The teacher's role changed from leader to advisor. Pupils were allowed to work at their own pace. Some completed the course before the end of the school year, others completed it the next year. He reported high pupil interest and buttressed this impression with questionnaire data.

To the degree that these studies reflect the field of motivation we can only conclude that individual pupil and teacher differences are still a prime factor in school learning. Perhaps Diamond's study relates most directly in that she compared ability groups and traditional and Bruner-like science students. She found a multiplicity of differences and not all favoring the Bruner-like program. Similarly Boyle found that motivation was not an either-or matter of intrinsic vs. extrinsic, but rather that the two approaches had complementary effects. Hardin's results buttress the general conclusion that motivation is multifaceted. In that

study, pupils saw affective factors as paramount, but teachers tended to stress intellectual factors. The other studies illustrate alternate views of motivation and related matters.

Audio-Visual

Early it became apparent that our topic encompassed too many complex facets to be adequately handled. Consequently less stress was placed on audio-visual. This was not done because of a lack of appreciation for the role of audio-visual in Bruner's scheme. It is just that the field is enormous and that Bruner assigned a facilitative rather than a central role to audio-visual.

Prylock's study is perhaps most interesting. He considered verbal and visual media and concluded that visual media were essentially inductive in character. The inductive character of media explains the attractiveness of visual media to producers of Brunerian curricula. Lichtenberg and Fenton, two producers of new curricula, stressed the importance of using media carefully designed for and incorporated into curriculum sequences. Haynes described an institute program where care was taken to model desired uses of media and to provide technical assistance in preparing media for use in specific instructional situations.

Olten et al. demonstrated the value of programmed sequences in teaching a variety of intellectual activities.

Anderson and W. Clarke reported programs in simulation. Both reported positive affective outcomes; Anderson reported mixed learning effects.

In a position paper Prylock (1968) found films and language communications to employ different cognitive processes. Film was seen as involving essential inductive processes and was therefore seen as a good source of vicarious learning. Language communications was seen as essentially deductive.

Lichtenberg and Fenton (1966) noted that audiovisual materials developed for expository presentations may not be suitable for discovery lessons. In their view A-V materials are designed to accomplish particular goals and may not function well when used to achieve other goals. They pleaded for audio-visual materials designed to achieve specific goals, for example inquiry.

Haynes (1966) reported that media played an important role in Fenton's 1965 NDEA summer institute. A large collection of materials were collected and were available for perusal by the institute participants. Apparently the morning lecturers made a point of using media and used it well. A specialist was on hand to help and advise participants in designing and locating media for their instruction. No evaluative data were presented.

Olton, et al. (1969) tested a series of self-instruction programs designed to improve the thinking and problem solving

of fifth-grade pupils. A total of 704 pupils in 44 classes participated. Statistical significance on a "wide variety of productive thinking measures" was found for the experimental program. Benefit was found for all sub groups and especially for pupils in less advantaged classrooms. Girls generally scored higher than boys.

C. R. Anderson (1970) compared learning of some behaviors related to consumer credit of groups taught by expository or simulated game methods. The behaviors taught were: answer factual tests, shop for credit, and sign most advantageous credit contract. The total senior class (280) of a high school participated as intact groups. He found no significant differences on any of his measures. Post hoc analysis revealed that boys taught by simulation could better compare available sources of credit, while all girls exceeded all boys on this measure. Business education and general education pupils learned more through simulated methods than through exposition, but college preparatory pupils learned equally well with either method. Anderson quoted earlier research which revealed no significant differences on measures of learning but high motivation for simulated methods.

W. Clarke (1970) reported contrasts in pupil and parent attitudes toward various value objects favoring pupils who had an extensive simulation experience. All of the pupils in the newest of three high schools in a midwest community

participated in a simulated political convention. A semantic differential instrument and follow-up questionnaire data was obtained. Data from a random sample of pupils from the other two schools was obtained. Comparisons of these data uniformly found pupils with the simulated experience reporting more favorable attitudes toward such value objects as social studies, simulation, and politicians.

Little can be concluded from these studies. No evidence was reported that refuted Bruner's assertions concerning media. The two studies dealing with simulation reported familiar findings. Simulated experiences stimulate participation, but do not produce superior learning on conventional measures. Programmatic approaches to teaching were found productive by Olten, et al., and many other investigators. Haynes and Lichtenberg and Fenton remind us that media must be properly used to be effective. Finally Frylock's conceptualization of media as requiring inductive processes should encourage its continued use with inquiry approaches to education.

Conclusion

Bruner's formulation for reform of curriculum and instruction involved four basic elements: structure, readiness inquiry, and motivation. It would not be possible to catalogue all of the curricula produced during the Bruner Decade that perported to employ a structured approach. As we have seen in this summary, structure was variously defined and not infrequently it was impossible to know how the reporter was defining structure.

As is the usual case, little evaluative research was conducted. Most of the reports included statements concerning perceived reception of the innovative curriculum. We have no way of knowing if these perceptions were self-fulfilling. When data were collected, it generally included generalized evaluative assessments, which are almost invariably supportive. The new it seems is always better than the familiar.

When comparative data were obtained the situation becomes less clear. Often the structured product produced better results according to some measure. The measure generally being the invention of the investigator. Insufficient details concerning evaluative instruments causes one to accept such results with reservations. Often standardized tests were used. When they were significant differences were harder to find, but then these tests generally measure goals other than those sought by authors of structured curricula.

We can seldom determine the degree to which an innovative program was actually implemented. Was the innovative approach given a fair trial is always an important question. An equally important question involves the other methods; were they fairly represented in the comparative test?

Data were found to support some of the new curricula. The structural concept does provide a workable test for what should be included in a program of study, thus helping the profession avoid the content clutter that too often obscures the valuable in conventional courses.

The notion of readiness does seem to have worked out. Young children were successfully instructed in a wide variety of topics. It does seem that learner readiness is more dependent upon how something is presented than upon the inherent complexity of the idea at its ultimate level of sophistication. This finding leaves open the question of what should be taught to young children.

The topic of inquiry received enormous attention. Inquiry, variously defined, was compared to every imaginable method of teaching with mixed results. Inquiry procedures often produced superior transfer learning as claimed by Bruner and many others, but not always. Suchman conducted the most elaborate study of inquiry and obtained ambiguous results. Factors relevant to individual learner and teacher differences and content variables seem to confound the question. With regard to these issues the findings of Bruce seem relevant.

Bruce (1969) agreed with an earlier study of Burnett (1964) that there was a "scarcity of research findings leading toward sound modifications of practice in science education (p. 415)." Bruce noted a persistence in promoting one type of teacher behavior when evidence suggests a relationship between kinds of learning and various patterns of teacher behavior. Other studies indicated that college study of science did not increase critical thinking nor understanding of science and that qualified science teachers and scientists did not differ in their understanding of science. The relationship between teacher behavior and pupil achievement appeared to be stronger than the relationship between teachers' science background and pupil achievement. Also, students trained to observe themselves adapted non-directive teaching procedures more easily than untrained students. (Apparently one can sensitize students to behavior that correlated with desired pupil outcomes.)

The question of motivation is even more complex. Bruner posed either-or alternatives. Motivation was seen as either intrinsic or extrinsic, i.e., good or bad. The real state of affairs appears to be much more complex. Pupils learn and learn well for all sorts of reasons including accidentally. Here again the complexities of individual differences play a critical role. The chemistry between teacher and learner appears to be most critical. An inspired teacher can produce superior learning and the learning is just as good as when it results from enormous learner interest in the topic.

In closing part I it seems appropriate to note a remark made by Klausmeier (1968) in reviewing Bruner, et al., Studies in Cognitive Growth. Klausmeier observed that Bruner's writing is persuasive, provocative, and bold and that he has a "disposition to generalize well beyond the experimental data." Perhaps that is what Bruner did in Process.

Part II

Preparing Teachers for the New Curricula

Introduction

Developers of the new curricula, that is, curricula built on the Bruner model, realized early that steps had to be taken to prepare teachers to properly teach it (Zacharias and White, 1964). They reasoned that teachers long accustomed to teaching particular course content in traditional fashion would be reluctant to abandon the security of the familiar. They also recognized the inherent conservativeness of higher education and that science at the university level was no better taught than at the secondary level. In response to these considerations curriculum developers often opted for summer institutes and teachers' guides.

Campbell (1964) indicated that strong evidence existed that suggested that teachers with reasonable knowledge of chemistry could satisfactorily teach CHEM Study with assistance of the Teacher's Guide (p. 90). Attendance at a summer institute where the teacher could become thoroughly familiar with the material and perform the experiments was highly recommended.

In this part, we will examine numerous programs that had teacher preparation as an important element. Included will

be consideration of preservice, inservice, and institute programs. Most of them were tied in some fashion to one of the new curricula or to one or more goals of the new curricula such as inquiry.

We will begin by reviewing studies and reports of attempts to institute one of the new curricula. Next we will examine attempts to prepare teachers to teach in a fashion compatible with one or more of the characteristics of the new curricula. Lastly, we will examine some attempts to prepare the trainers of teachers of the new curricula.

Instituting New Curricula

This section of the review is divided into three parts. The first deals directly with the title of the section: Instituting New Curricula. The second topic will be consideration of the need to change teacher education in some fundamental way. The last section will identify evaluative guidelines and strategies for curriculum innovation.

Instituting New Programs. Authors of articles reviewed in this section describe programs undertaken to prepare teachers for curriculum innovation. Wooten briefly describes a "kick-off" meeting for the 1959-60 field trial of SMSG mathematics materials. Thurber describes an inservice program that accompanied the introduction of Science: A Process Approach in Florida. Class describes an early national field

trial of BSCS natural science materials. Marshall describes preparing teachers to introduce the PSSC physics program. Herlihy, Cole, and Herlihy describe a team approach to preparing teachers for Man: A Course of Study. A regional approach to curriculum innovation is reported by the Bi-State Science Project. Another regional approach is described by V. P. Weaver.

Wooton (1965) described the preparation of teachers for the 1959-60 field trial of SMSG materials. He noted a one day Chicago meeting for representative teachers from experimental centers. Attending teachers had an opportunity to discuss the materials with the authors (p. 89). Because the materials contained much new content each center enjoyed the services of a mathematician.

Tourber (1970) reported outcomes of a program designed to help elementary school teachers with Science: A Process Approach. The training program included a self-study program for the text, instruction and suggestions concerning ways to teach the science materials in the form of 25 minute twice-weekly telecasts, a specially prepared teacher's handbook, and formal instruction. The inservice program was tested in Florida during the school years 68-69 and 69-70. Participating teachers were divided into three experimental groups and one control group. The experimental group received varying amounts of instruction while the control group received instruction regarding science apparatus. Pre-post

contrasts for experimental groups showed significant growth as measured by the Elementary Science Teachers Inventory. Earlier data included measures of pupil attitude toward science and observations of classroom process. Both pupil measures produced significant results in favor of the experimental groups. The investigator concluded that the inservice program was effective, economical, and efficient.

Glass (1964) described the preparation of teachers who piloted Biological Science Study Committee (BSCS) materials. These teachers were given a briefing on the materials in August. Materials were received in November and January for trial during school year 1960-61. All teachers were clustered in centers and each center enjoyed the services of a biologist. Pilot program teachers had weekly meetings, were paid stipends for their extra effort, and given a small budget for expenses. Laboratory work was done most successfully by teachers with relevant training. A policy statement concerning the academic preparation of teachers of BSCS materials was made in 1960. The statement called for a full year of biological sciences and an additional year of related sciences and mathematics. A handbook or teacher's guide was also prepared for the 1960-61 field trial. The handbook had three sections: "a background to biology," "Invitation to Inquiry," and "notes and references." The "inquiry" section contained a number of topics for classroom

inquiry. Apparently the handbook was only slightly used. It has since been revised and enlarged.

Marshall (1964) described an inservice program used in Florida during 1959-60 to prepare teachers to teach Physical Science Study Committee (PSSC) physics. A physics course for teachers carrying six semester hours of graduate credit was taught by a cadre of professors prepared at MIT. The course met for two weeks prior to the opening of school and weekly thereafter for 30 weeks. The course dealt primarily with physics, but heavy emphasis was placed on pedagogy and PSSC philosophy. Teachers had an opportunity to perform many of the PSSC experiments and to watch and discuss others. The immediate "need to know" of participating teachers was seen as strong motivation in this program. The weekly meetings were also seen as a source of security for teachers venturing on new ground. The inservice program also helped schools and universities work more closely as they were in constant contact. Questionnaire data from participating teachers generally rated PSSC physics excellent or good. A comparison of college performance in physics of students with PSSC and traditional high school physics found no significant differences. Note is also taken of the importance of administrators to successful innovations, of teacher enthusiasm, and of teacher preparation. Marshall also expressed a preference for inservice programs over summer institutes. He seems to feel the immediacy of the "need to know" as important.

Herlihy, Cole, and Herlihy (1971) described a "campus team" strategy for inservice and preservice education of teachers and curriculum innovators. Methods professors and campus school teachers were teamed and taught the theory, design, and methodology of a process oriented social studies curriculum, Man: A Course of Study (MACOS). Campus teams conducted inservice programs in nearby schools adopting MACOS materials. The program consisted of three-day preschool workshops for participating teachers and administrators and twenty biweekly classes through the school year. Thus, the program not only provided an initial orientation to the curriculum, it also provided close and continuous support for participating school personnel throughout the initial year. The authors reiterate statements of earlier ERIC curriculum innovators to the effect that prior written agreement concerning role responsibilities and financial commitment is an essential condition for success.

The use of MACOS materials was central to the program. Preservice teachers learned to use the materials in their social studies methods class and when possible later during student teaching with an inservice teacher also taking training with a campus team. Inservice teachers learned from the preschool workshop and the biweekly classes, but more importantly from using the materials in class. Thus, participants learned the materials and the processes necessary for their

proper implementation simultaneously. It was hoped that a multiplier effect would be achieved. That is, a limited number of campus teams would train a larger number of preservice teachers who could then work for further adoptions and training programs when placed. Inservice teachers could be expected to persist in using the program where adopted.

The program was judged an all around success based on questionnaire data gathered from all participants. No school dropped from the program and a number of additional schools requested participation during the second year.

The Bi-State Science Project (1970) was organized in 1967 for the purpose of upgrading science education in northwest Missouri and southern Iowa. There were three objectives for the program: improvement of teacher attitute toward teaching of science, development of teacher knowledge and skills of science, and curriculum implementation. The project featured four-week summer workshops where selected elementary teachers worked with the materials that they would use in their classrooms during the regular term. Specialized consultants were used to help participating teachers through the summer and academic year and to hold monthly meetings through the academic year. Microteaching for teacher self-evaluation was also part of the program. The science programs instituted were: Science Curriculum Improvement Study (SCIS), American Association for the Advancement of Science (AAAS), Elementary Science Studies (ESS), and Experiences

in Science (EIS). In all, 250 teachers and 17 administrators from 24 school districts in Missouri and Iowa participated. The project was jointly funded by local school districts and the federal government. Significant improvements on the MTAI and Leake's attitude survey were reported for teachers. Teachers did not change with regard to Rokeach Dogmatism Scale. Significant improvements on Shoresmen Activity Inventory and Shoresmen Interest in Ideas Inventory were reported for some people participating in the program. No differences between experimental and control pupils were found on the Stanford Achievement Test for Science. Interviews of a sample of participating teachers revealed the following. Students readily adapted to the process, or "doing" aspect of the program. Pupils were more interested, as indicated by noisy classrooms. A let's-find-out attitude was apparent. Students took more responsibility for their own learning. Finally, it was noted that there was excellent support from school administration at all levels for the program.

V. P. Weaver (1970) described a social studies curriculum development program conducted by three rural Maryland counties with federal support. Two phases were described. In the first phase, a grand design for a K-12 program was developed with the help of consultants. Units were prepared and materials gathered during Phase Two which consisted of a three week summer workshop and a four day follow-up workshop. The unit

development work was repeated during the following school year. Major benefits of the program were seen as: promotion of co-operation among counties, articulation between grades, involvement of teachers, and teachers' realization of the importance of updating and revising curriculum.

Considered in chronological order one can perceive considerable increase in sophistication. The one day conference noted by Wooton could hardly be considered adequate, but that was back in 1959. The approach used by BSCS combining pre-school conferences and regular meetings of participating teachers in pilot areas was more elaborate and employed a pattern that saw considerable use. Continuous contact with other teachers participating in innovation was an important feature of the PSSC Florida program described by Marshall. Marshall also reported data that suggested some success for the program. Data collection plus variations in inservice treatments were reported by Thurber. Thurber's study not only established an effect on teachers, but more important, he sought to establish an effect on pupils. Even more sophisticated was the program described by Herlihy, Cole, and Herlihy. Their program coordinated preservice and inservice training, experience with the materials as featured in the PSSC program, and made provision for a multiplier effect as preservice teachers took positions in the profession.

The two regional studies demonstrate that something can be done on a less than national scale even though both projects enjoyed outside help. These two studies lend support to Schneider's (1969) call for material relevant to pupils in a particular locale. The local character of these projects combined with high user participation in their introduction (the Bi-State project) or development (Maryland) might well contribute to their success if we can believe the assertions of Johansen that participation in formulation is correlated with implementation.

In a correlational study based on data obtained from 195 teachers randomly selected from four Illinois school systems Johansen (1967) concluded that teacher participation in, or perception of influence on, curriculum making significantly increased the likelihood of teacher implementation.

Fruth and Yee (1971) employed cooperative curriculum development with apparent success. They tested the effectiveness of history units developed by an Integrated Black History Institute. Twenty-five classes of intermediate-grade ghetto pupils from eight metropolitan areas received instruction with the new materials; an equal number of matched classes did not. Classes receiving instruction achieved very significantly higher scores after instruction; non-significant differences were found on a duplicate form pretest. Certain attitudinal variables were examined, but no significant

relationships were found. Yee concluded that the program of inservice training and cooperative curriculum development as employed in this project could make a difference in pupil learning and perhaps in the long run a difference in pupil attitudes.

Parke (1966) noted some important conditions that should be satisfied if teacher participation in curriculum development is to be successful. Parke reviewed research relevant to the use of teaching materials from 1964-66. She noted that research "fails to deal significantly with the classroom teacher's problems of coordinating and synthesizing available learning materials (p. 380)." Specific conclusions identified by Parke included that teacher participation in the development of curriculum guides did not necessarily result in increased usage, unless teachers were recognized for the time and contributions they made and unless necessary organizational conditions were satisfied. A number of findings related to the use of media and programmed instruction were consistent with Bruner's recommendation that media must be incorporated into learning experiences rather than being used as aids.

Finally R. S. Miller (1971) described a curriculum evaluation program that involved comprehensive planning. Comprehensive planning involved teachers and administrators at each stage from identifying objectives to interpreting results. Steps in the

procedure included: identifying objectives, preparing performance indicators, administering indicators, and comparing pre-post results. The program was carried out in Radnor Township, Pennsylvania and involved 3,200 pupils. Impressionistic evaluation held that teachers became more critical of what they were doing and teaching and more aware of their pupils. The program involved mathematics, but Miller feels it sufficiently flexible to be applied to other subject areas.

Changes in Teacher Education. Not surprisingly some investigators called for fundamental changes in teacher education. Institutes and inservice programs can have an effect on the way teachers in service teach as we have seen. Unless one sees advantages to immediate retraining upon graduation, one naturally turns to thinking about initially preparing teachers to teach the new curricula.

R. B. Smith called for a shift in teacher education that would complement the major shift in the new curricula, that is, a shift away from categorized information to an emphasis on inquiry. Haberman called for a similar shift, but doubted that it could be obtained through higher education. He called for professional, rather than liberal, education of teachers. Any program of teacher education requires procedures for evaluating outcomes. Shulman used one to observe inquiry behavior of teachers; Ribble designed and tested an instrument to assess teacher adherence to a model used by the Economics Project.

R. B. Smith (1968) observed that recent curricular changes that placed stress on inquiry instead of content have not been met by complimentary shifts of stress in teacher education. He held that the classical view of science, where knowledge is categorized and further broken down, is obsolete. He asserted that in the modern conception, knowledge is constructed and what counts is the inquiry process that produces knowledge. He felt that teachers should be able to evaluate the psychological structures of pupils, relate learning experiences to fundamental relationships already in the pupil's repertoire, recognize learning as an active process, understand that concepts are learned in context and arise out of inquiry, and finally be aware that pupils must discover the form and patterns of relationships.

Haberman (1968) noted three conditions that mitigate against programs of teacher education. The first related to the incorporation of teacher education into higher education. This condition shifted the emphasis from true "knowledge," i.e., the doing of something, to knowledge "about" classes of events. The other two mitigating conditions seen by Haberman were the course format and perceptions of teaching modeled in higher education. He proposed shifting the site of teacher education to the schools and communities, requiring students to plan and control their own progress, and basing evaluation on real performance with pupils, colleagues,

and parents. In short, he proposed a program of professional rather than liberal education. He went on to describe mini-courses and how they might be used in a program of professional preparation.

Shulman (1969) reported a model developed to observe and score inquiry behavior of preservice teachers. It was found that certain predictor variables can be used to predict inquiry behavior. Effects of student teaching experience on inquiry performance are also reported.

Ribble (1967) developed an instrument designed to assess the adherence of Economics Project teachers to structure prescriptions and discovery method prescriptions of the project. The instrument was judged to be reliable and objective. Four observers made five visits to each of ten project teachers. Using Ribble's instrument they were asked to predict pupil achievement on the project's criterion measure. The predicts proved to be insignificant.

Program Guidelines. Two investigators reported guidelines for program establishment. M. Jensen (1969) identified 23 guidelines found useful in inservice programs. Her guidelines included the use of media in demonstrations and giving rewards to innovators.

Mahan (1971) described sixteen guidelines for perfecting curricular change. The guidelines grew out of the Eastern Regional Institute for Education (ERIE) experience in innovating the curriculum Science-A Process Approach (SAPA) in 53

elementary schools. Over 700 teachers and administrators and 27,000 pupils were involved. Among the guidelines were admonitions to obtain written agreements clearly describing participant rules and responsibilities, formulation of a strategy of curriculum installation, and to require school districts to invest a substantial percentage of local funds into the program. The specifics of the guidelines grew out of observed contrasts between schools designated as pilot programs and others designated as demonstration. By demonstration Mahan means university laboratory schools where SAPA experienced considerably more success. This led him to an examination of the differences between the two classes of schools and formulation of the guidelines.

Preparing Teachers to Teach the New Curricula

A large number of studies and reports dealt with preparing teachers to teach the new curricula. These studies and articles varied greatly in complexity. Most featured a single treatment, often an institute or workshop. Others were comparatively sophisticated in that a single treatment was compared to a control group, or to other treatments. "Single treatments" and "treatments compared" are major headings of this subsection of the review.

Single Treatments

Some studies were designed to improve teacher knowledge of content included in the new curricula. Other studies and articles dealt with topics associated with teaching the new curricula.

Improving Teacher Knowledge. The instructional area of mathematics, especially elementary mathematics, received the greatest attention. Developers of mathematics curricula seem to have favored visual media, i.e., film or video broadcasts. Perhaps they felt an urgency to communicate the mathematics upon which the new math curricula were built to the teachers using the materials. That appears to be the case in the two projects reported by J. F. Weaver. Cannon and Oakes reported a film based inservice program conducted in Tennessee. The Tennessee program utilized the same series of films in a wide variety of ways. The same series of films was used in another project reported by Moray. Finally, R. B. Davis takes note of a teacher's manual designed to help teachers with mathematics concepts employed in one of the innovative mathematics programs.

J. F. Weaver (1963) reported an inservice program designed to acquaint elementary teachers with basic concepts of the new mathematics. The Des Moines school project featured weekly telecasts on a variety of new math topics. The telecasts were viewed by groups of teachers after school. A weekly bulletin

was distributed to prepare teachers for the telecasts and follow-up group discussions were held in the schools. Project personnel and the television teachers visited viewing groups to obtain feedback. Teachers reacted favorably to the television teacher who became a "real" person through personal contact with teachers during the group meetings. Teachers made serious attempts to translate their learning of the mathematics content into their own classrooms, but encountered difficulties due to lack of material, failure to fully understand content, and insufficient guidance from program notes. Members of the visitation teams agreed that the films and lesson notes should be revised. Both should deal exclusively with mathematics. A parallel series dealing with pedagogical considerations was suggested. Weaver concluded that television alone was not adequate for inservice education; follow-up group discussions were important. Telecasts should be offered several times during the week instead of once to accommodate differences in the schedules of teachers. A need was also seen for careful orientation of participating teachers and strong support from principals in their role as instructional leader.

J. F. Weaver (1963) described the Wisconsin School of the Air Patterns in Arithmetic (PIA) project. PIA was designed to instruct fourth, fifth, and sixth-grade pupils in mathematics. Biweekly filmed lessons with accompanying pupil

exercise materials and teacher guides were used. The biweekly films were broadcast as were 11 or 12 (depending on grade) inservice programs. PIA was designed to upgrade immediately intermediate grade arithmetic instruction. It was hoped teachers would benefit from the project. Weaver accompanied a visitation team. He reported many variations of the program in actual use, but concluded that it was a fine effort on the balance.

Cannon and Oakes (1969) reported the massive use of the NCTM films, Mathematics for Elementary School Teachers for inservice training in Tennessee. The films were used in every imaginable way from self-selection of individual films with no instruction or discussion to carefully sequenced presentations with accompanying instruction, discussion, and use of accompanying text. Data gathered for a doctoral study was reported. These data were interpreted as suggesting the films were equally effective in all applications. High school teachers of mathematics were often used as instructors in these programs. Impressionistic evaluation and attendance suggested that the films were popular; more were desired. Cannon and Oakes concluded that the films were useful for inservice training of elementary teachers of arithmetic.

Moray (1967) described the design and development of a series of films for inservice training of elementary teachers in mathematics. The series was entitled Mathematics for

Elementary School Teachers. A sample of 147 teachers rated the content level of the films as neither too difficult nor too easy. The accompanying text was similarly rated.

R. B. Davis (1969) discussed the guide developed by the Madison Project designed to accompany the teacher text "Discovery in Mathematics." The guide basically dealt with arithmetic and algebraic concepts for the elementary school.

Little can be said about the effectiveness of these programs. Little data were collected and that which was collected was highly impressionistic. Visitation teams were used in the Des Moines and Wisconsin programs. Their impressions were reported as favorable. Data referred to by Cannon and Oakes relevant to the Tennessee program suggest that the films used were found effective in many formats, a rather unusual finding. Apparently these film-based programs were designed to acquaint elementary teachers with some aspects of the new math as rapidly as possible. They seem to have achieved that end.

Science received some attention. Markham described an early workshop designed to teach teachers basic scientific methods, especially methods of observation. Apparently the program was successful. Westmeyer reported an unusual program. The program had as its goal the development of a hybrid course of study in chemistry in Texas. Teacher demonstrations played a central role in the project.

Markham (1962) described an early NSF inservice workshop in general science for primary teachers. The year long project was conducted each Saturday. Mornings were devoted to lectures on important science topics and afternoons were turned over to related laboratory work or to field trips. Graduate credit in science education was given. Stress was placed on methods of science with particular stress on scientific observation and not on teaching. Questionnaire responses gave strong support for the program, especially the laboratory portion. The lectures were often seen as too sophisticated or too hurried. Teachers reported science permeating all the subjects they taught during the regular work week. An examination revealed significant command of science content and staff members were gratified by the enthusiasm of the participants. Markham concluded by asserting a continuing need for such workshops to help experienced teachers gain or regain confidence in their ability to work with science. She called for additional institutes to train science supervisors to provide the continued assistance participants reported needing.

Westmeyer (1966) described an inservice project in Texas designed to produce a high school course of study in chemistry built upon the state text and laboratory manual. The project also incorporated CBA and CHEM Study materials and experiments into the Texas course of study when appropriate. The project took the form of an inservice chemistry course and instruction, each conducted on alternate Wednesdays. Demonstration teaching

was a part of the program. No evaluative data was presented.

Crowell reported on an inservice program designed to teach transformational grammar through videotaped models. He succeeded in teaching transformational grammar to his models, but he did not obtain the desired level of learning with his target population.

Crowell (1969) studied the effectiveness of an inservice program for teachers of English on transformational grammar. The program sought to prepare the teachers of an Illinois school district to teach transformational grammar through videotapes of four district teachers modeling the desired behaviors. The four model teachers received intensive preparation which included ten two-hour sessions and outside reading. The four one-hour model tapes prepared by these teachers were shown to the district's English teachers for grades 7-12. The training of the model teachers was judged successful, but the taped lecture series was found to be beneficial, but generally inadequate.

Teaching the New Curricula. Most of the teacher preparation programs attempted to alter classroom behavior in such a way as to promote inquiry or a related activity such as higher order questionning or inductive reasoning. A few had to do with more general concerns of motivation and skill acquisition.

Inquiry Related. Again the key study appears to be that of Suchman (1962). Suchman's inquiry training program featured confronting elementary pupils with problematic situations and a question, the "why". In order to answer the question, the pupils had to search for data in the phenomenon itself. They might also ask the teacher questions, but they could not ask the teacher for a general explanation. Pupils had to formulate their own hypothesis to explain the data.

Suchman trained twelve elementary school teachers selected for their interest in the project to use his inquiry materials. The training program consisted of three hours of training per day for eight weeks. The content of the training included theories of cognition, emphasis of inductive learning, review of Newtonian physics as it related to the stimulus episodes of the inquiry program, and construction of inquiry lessons and practice in conducting inquiry training. Trainees practiced on a group of 18 sixth-grade children who were brought in daily for an hour. One teacher worked with the children while the rest observed. A critique followed.

The effectiveness of the program was judged in terms of a criterion test called "questest." In each school having inquiry training there was an equivalent control group selected for comparison purposes. Inquiry groups were given one to two hours of inquiry training per week. Control groups were shown the same stimulus films but instead of inquiring were taught didactically. The training period covered 24 weeks for both groups.

Three criterion measures were used. One was used to measure conceptual growth. A second, the questest, was used to determine the amount of information and understanding about the episodes the child could reveal during twenty-five minutes of questioning. The third measure yielded an indication of the kinds of intellectual operations the children performed in searching for causal relationships in the stimulus events.

Both the experimental and controlled groups improved significantly over the 24 weeks of training. There were no differences between the two groups on final measures. A trend in favor of the experimental group was found for Questest subsection A, mastery of principles, and subsection B, ability to identify necessary conditions. No significant differences were found for subsection C, ability to identify parameters. For Questest, process, very significant differences were found in favor of the inquiry group. That is, the inquiry group asked more questions. A complex analysis of the types of questions asked was performed. Many of the results proved non-comparable in that the regression slopes for the two groups was significantly different. In general, the experimental group exceeded the control group in all catagories.

Visual media were also popular with those who wished inquiry to become the dominant classroom mode. Szabo described a set of filmed models developed by the Illinois mathematics project to illustrate desired teaching strategies. Dagne and Bales noted another, more recent Illinois mediated inservice program.

Szabo (1964) reported on the University of Illinois Committee on School Mathematics (UICSM) project to produce four categories of films for use in summer institites. The films were designed to illustrate: 1) classroom development of certain mathematics topics; 2) continuity of instruction; 3) a theory of instruction; and, 4) certain mathematics content. In the first category of films, segments of instruction were lifted from various lessons to show how the topic was developed over time. Whole lessons were shown in the second category. The films were seen as a practical substitute for live observations of classroom interaction for NSF mathematics institute fellows. Eight millimeter sound cartridge copies of the films were made for use with conveniently located projectors. Among the advantages seen for the cartridge films were: possibility of repeated viewing, stimuli for impersonal discussion of teaching, viewing the development of a concept over time, and availability of examples of good teaching. No evaluative data was reported although plans for a frequency of use count were reported.

Dagne and Bales (1969) described an inservice program that utilized television broadcasts. Rapid changes in methods and materials, teacher isolation, and differences in preservice training programs were given as reasons for an ongoing inservice program. The program was designed with three goals in mind: improvement in required human skills, improvement

in required technical skills, and improvement in necessary conceptual skills. Consideration was also given to the power of inservice media to effect goal learnings. Television broadcasts followed by group discussion was the pattern frequently employed. Stress was placed on inductive, inquiry, and experimental-discovery approaches to teaching. Favorable impressionistic testimonials were presented and a more rigorous evaluation was described but not reported.

Little can be concluded from these two studies because no firm data were collected. The ideas do seem agreeable and reasonable. Leonard and Gies attempted to encourage inquiry and self-directed learning through the production of local materials.

Leonard and Gies (1970) described a two semester inservice course designed to promote pupil inquiry and self-directed learning. Thirty teachers and their student teachers were enrolled. Each pair produced at least one instructional "pacquette" (coordinated resource unit).

Several studies considered behaviors related to inquiry. The Northwest Regional Education Laboratory (NWREL) developed an inservice program designed to help teachers promote higher cognitive processes. Peters' study did not involve a treatment, but the presence or absence of formal training in logic. He found training in logic and critical thinking correlated.

The NWREL developed an inservice program to improve teacher competence in encouraging higher level reasoning in

pupils. Pupils learn reasoning by argument and discussion and by having to substantiate statements they make during class discussion. The materials were designed to promote the development of four basic capabilities: 1) promote students' thinking skills; 2) managing learner experiences; 3) teamwork skills for school personnel; and 4) provide support for continuous learning by school personnel.

Peters (1971) administered a test of critical thinking to 55 Kentucky student teachers of English. He based the test on exercises from a standard high school text. He found that teachers generally could distinguish between fact and opinion, identify either-or statements, etc., but that students with courses in logic could do so much better. He concluded with a plea for formal training in critical thinking.

Process oriented curricula were of interest to several investigators. Westin and Smith described a summer institute program designed to promote critical evaluation of fundamental social concepts. They found it worthwhile to let their program be guided by student interest. John described a multimedia approach to an elementary process oriented social studies curriculum. Some units were found to be especially well received. Process was also the concern of an Eastern Regional Institute for Education which created inservice materials.

Westin and Smith (1968) described an NDEA summer institute for teachers conducted by the Center of Research and

Education in America. The institute was organized on three assumptions. First, "meaningful dialogue" among student and instructor participants was of greater value in considering democratic concepts than a teacher to student "information flow." Second, academic specialists were best used to help participants frame questions rather than answering them. Third, process or a self-conscious analysis of issues and values was of great concern. To carry out their objectives the staff utilized case studies, socratic questioning, and sensitivity training. Finally, an attempt was made to model democratic decision making and life style in the conduct of the institute. Teachers and administrators participated in the institute. The schedule followed by the institute was: general presentation in the morning, psychological and educational analysis in the afternoon, and sensitivity groups in the evening. The basic schedule was altered due to the urban riots of 1967 which made real the concepts of liberty, equality, and justice that were central goal concepts for the institute. Weston and Smith felt the 1967 workshop was more successful than an earlier workshop because they were better able to respond to the feelings and interests of the participants.

John (1970) described a multi-media approach to the teaching of process oriented elementary social studies pioneered at Brunswick, Maine. The goal of the project was to incorporate outstanding facets of recent curriculum projects into a program

that would be relevant to the children of Maine. Separate evaluations were made of the process, media, and production portions of the three year program. Inservice training for the process portion consisted of a one-week pre-school workshop and 15 after-school workshops. In response to a questionnaire teachers identified four workshops as especially useful. They were: planning a unit with teachers from a single grade; teacher sharing of interesting and useful techniques; demonstrations involving pupils; and consultations with media specialists.

Working on the premise that teachers must become managers and guides to successful living in an unpredictable world, the Eastern Regional Institute for Education (ERIE) created inservice materials designed to help teachers teach process rather than dominate the learning activities of the classroom. ERIE-designed Process Education for Teachers (PET) packages placed teachers and teacher educators in student roles to better understand the learning process.

As with the other studies of this section little data were collected and hence little concluded. A number of apparently workable ideas were presented. Perhaps the most encouraging of the lot was that of Rudin who described a large scale attempt to promote productive thinking in California.

Rudin (1970) reported a large study of inservice education. The program included three training elements: development

of six productive thinking skills, use of instructional materials on contemporary social issues, and a set of methods or teaching strategies. Approximately 500 teachers and 15,000 pupils participated in the program. A unique feature of the program was the use of teacher facilitators in each participating school. Teacher facilitators were selected by participating teachers. Rudin reported that it was easier to change a faculty than a teacher and that the failure of inservice programs was due more to faulty design than teacher resistance.

General Concerns. The reports collected under this heading vary in their concerns and in specificity. The most general along both dimensions was the program described by Polanski which featured regular showing of films to interested teachers. The most specific project was that of Niedermeyer who developed a teacher training package designed to help teachers use a communications skills program previously developed.

Polanski (1968) described an inservice teacher education program planned for use by the San Diego Schools. A committee of teachers selected a list of inservice films of interest to the teachers. One film was to be shown each month while the teacher's class was watching another film in the auditorium. No credit, grades, or papers were required. No results were reported.

Niedermeyer (1970) produced and field tested a teacher training program to prepare elementary teachers to use the Southwest Regional Laboratory's (SWRL) first year communication skills program. SWRL was motivated to produce the program after field testing their communication skills program in 1968-69. At that time they found that teachers of comparable pupils produced highly variable results. There was some indication that district supervisors responsible for preparing teachers to use the communication skills materials did an inadequate job. In preparing the materials Niedermeyer proceeded from a general statement of goals to specific, operationally defined objectives for the program. The resulting package was a multi-media affair carefully designed to provide instruction and practice in the knowledge and skills required to utilize the communication skills program. The initial package was tested on SWRL personnel and revised. The revised materials were then tested on a population of paid kindergarten teachers during the summer of 69. The package itself was used in the fall to prepare teachers to use the skills program through the school year 69-70. The follow up procedure was outlined but no data was provided.

A variety of projects round out this subsection. Jackson and Rogge described a project that utilized demonstration centers to promote teaching of the gifted. Jaffa and Coffey used interaction analysis to alter classroom patterns of verbal

communication. Borg advocated minicourses to help teachers acquire specific teaching techniques such as skill in questioning. A microteaching-like technique was employed by H. J. Andersson to improve the teaching skill of some elementary teachers. Finally, Hite reported a program that gave beginning teachers reduced loads to help them improve in skill.

Jackson and Rogge (1969) described nine centers established in Illinois to demonstrate teaching the gifted. The centers were visited by approximately 10,300 teachers through 1967; demonstration teachers were trained in summer workshops; and administrators were given instruction in conducting in-service programs.

Jeffs (1969) taught Flanders interaction analysis to four teachers of mathematics and social studies as a part of an inservice program. He found that teachers learning interaction analysis increased their use of pupil ideas and promoted greater frequency of pupil-initiated talk. A number of other findings indicating an increase in indirect teaching and a free atmosphere were reported.

Coffey (1969) described an inservice training program in elementary school science. Results indicated that programs for changing teachers' verbal classroom behavior are feasible and can be conducted for a modest cost.

Borg (1969) reported a series of minicourses designed to teach various specific teacher behaviors using the techniques

of microteaching and filmed illustrations by model teachers. Included is a description and evaluation of the first mini-course, "Effective Questioning in a Classroom Discussion."

H. J. Anderson (1968) reported an inservice program conducted at Hinsdale, Illinois. The central feature of the workshop was weekly meetings in a demonstration classroom equipped with television recording equipment. Participating teachers met during school time, having been relieved by substitutes paid by the district. Teachers met in groups of 15-20 by grade level. The chief aim of the workshops was to help teachers improve their methods. Considerable use was made of demonstration teaching with small groups of children and peer critiques. No evaluative data was presented other than the usual observed participant enthusiasm.

Hite (1967) studied the effects of an inservice program on beginning classroom behavior. An important feature of the program was a reduced teaching load during the internship. A number of measures were used. He found that experienced teachers can be trained to use observational checklists and arrive at a fair degree of agreement with other trained observers.

Four studies included a practice component. Manning reported a program that gave undergraduates an opportunity to tutor while enrolled in a reading methods course. Hunter reported a "cross-age tutoring" program that gave students

an opportunity to work with several age-grades. Marcus reported a tutoring program that afforded undergraduates an opportunity to work with pupils suffering learning difficulties. Beldin reported a simulated environment designed to teach reading diagnostic skills.

Manning (1969) described an inductive reading methods course conducted at the University of Minnesota in 1966. Students were given instruction in reading diagnosis, then conducted individual tutoring sessions with remedial reading students. Tutoring was followed by seminar discussions of instructional problems. Group reading instruction was also conducted.

Hunter (1968) recommended a technique referred to as "cross-age tutoring" to bring more methods into methods courses. She felt that too much emphasis was placed on the learning of content and planning for teaching in ordinary methods classes. Cross-age tutoring referred to activities in which older children tutored younger children. Students were assigned in trios, including a methods student, a fifth or sixth-grader, and a second or third-grader. Hunter worked with the methods students who tutored the intermediate grade pupils; the intermediate grade pupils tutored the primary grade pupils. The program was conducted in a public school. Observations and analysis of teaching was stressed throughout the procedure. Methods students learned two languages of teaching: Flanders system and the Revised Verbal Interaction Category System. Hunter reports that all participants were satisfied with the program.

Marcus (1970) described an established tutoring program for elementary education students at Louisiana State. Students tutored pupils identified by the special education center as having language problems. In doing so the students became familiar with childreas' literature, ways of making the literature comprehensive, and ways of encouraging children to express themselves. Informal diagnostic techniques were also taught. The methods course acted as a seminar which gave students an opportunity to solve the problems they were encountering with their pupils. No evaluative data were presented, but the program has moved from experimental to permanent status.

Beldin (1969) advocated the use of simulated environments to teach elementary skills in diagnosing reading difficulties. Text-lecture techniques were seen as satisfactory for teaching basic knowledge, but a responsive environment was seen as required for teaching diagnostic techniques. Audio-tapes, video-tapes, and transparencies were seen as useful in the early stages of skill development.

Three studies dealt with persistent concerns of teacher education. Alschuler dealt with motivation; Sullivan with teaching psychological concepts and principles; and the District of Columbia Teachers College with individual differences.

Alschuler et al. (1969) discussed a teacher's manual for a course in achievement motivation for adolescents. The manual was developed from a project to discover effective ways

of increasing motivation. Included in the manual was background material on the subject of "psychological education" and a review of research on achievement motivation.

Sullivan, et al. (1967) used transcripts and coordinated photographs to teach psychological principles and concepts of learning. Sequences illustrating several important learning principles and concepts were developed along with sequences illustrating single instructional lessons in which students failed or succeeded to obtain desired objectives. No evaluative data were presented.

An inservice training program developed by the District of Columbia Teachers College (1969) was designed to aid in individualizing instruction. Six centers in the city developed basic concepts.

Improving Teacher Attitudes. Attitudes are changed toward some value object. The objects grouped under this heading are varied. The two studies of Butts had a course as their value object; Carswell and Kurfman, materials from the High School Geography program; and Lindsey and Filson had a new approach to English as a value object. Treffinger described a conference designed to change teacher attitudes toward creativity.

Butts (1969) studied the receptiveness to change of a population of 19 elementary teachers taking inservice training in the curriculum Science--A Process Approach. He found experienced teachers to be more receptive to new and fresh

approaches to teaching. Competence in science was associated with positive attitude change toward the new curriculum, but grade taught was not.

Butts (1969) studies some factors associated with attitudes of 69 elementary teachers participating in an inservice program designed to acquaint them with a new curriculum, Science--A Process Approach. A semantic differential technique was used for pre and post treatment measures. In general the program was successful in improving the attitudes of participants toward the new curriculum. He found grade level taught, a significant predictor of positive attitude change for primary but not for intermediate grade teachers. Teachers with little previous experience with science developed more positive attitudes. Previous teaching experience and school location were not related to attitude changes.

Carswell and Kurfman (1971) studied the effectiveness of three five-hour kits of self-contained materials for pre and inservice education of geography teachers in changing attitudes toward the topics, materials, and procedures advocated. The kits dealt separately with simulations, use of media, and evaluation. A sample of four groups of 16 instructors was drawn from a population of 64 groups participating in the program. The four groups included preservice grography education, preservice social studies education, and a control group of preservice social studies education. An instrument

entitled Basic Attitudes Toward Social Studies (B.A.S.S.) was developed for the project and used to assess pre-post workshop attitudes. All groups showed sigaificant gains in attitudes from experience with two of the three kits. The media kit was not found to change the attitudes of the participants, perhaps because negative attitudes toward the use of aerial photographs offset other gains. Variance analyses of attitude changes of the four groups of instructors toward each of the three kits revealed no differences for simulation, but significant differences not favoring the control for the other two kits. Questionnaire data indicated that all groups were "very positive" toward the materials. The investigators concluded that each of the kits was successful as indicated by B.A.S.S. and questionnaire results.

Lindsey and Filson (1968) sought to discover whether teacher ideas and performance could be changed by a short English extension course on the principles of composition, practical applications of linguistics, and various approaches to teaching slow learners. In the program 66 Illinois junior and senior high school teachers in several schools received three to four weeks of inservice training. Three instructors were involved. Questionnaire data regarding beliefs and teaching procedures were gathered before instruction. Participants were interviewed one month or 12 months after instruction. Lindsey and Filson found that 94% of the teachers claimed

changes in teaching performance and 61% claimed changes in thinking. Not all of the reported changes coincided with the main ideas of the instructors, but few teachers expressed any constraints against utilizing the new ideas.

Treffinger (1968) assessed the effectiveness of an in-service program concerning creativity on 250 upstate New York teachers and administrators. The workshop consisted of one-hour presentations followed by group discussions. The program lasted four days. Pre-post assessments of attitudes using Likert-type scales and a five point rating scale demonstrated important shifts in attitudes. Treffinger concluded that workshops on this pattern were valuable in developing increased understanding of creativity.

Again, the last study is perhaps most interesting in that it deals with a central element of all programs of teacher education. Harrison's value object was progressive educational values. He found that students change toward and then away from progressive ideals during a professional semester.

Harrison (1968) assessed the attitudes of teacher education students at the beginning of a professional semester, just prior to student teaching, and at the end of student teaching. He also assessed the attitudes of their university instructors and cooperating teachers. Kerlinger and Kaya's Education Scale VI which was designed to measure progressive

and traditional education values was used. Harrison found that the students' attitudes changed from traditional to progressive under instruction during the professional semester and back to traditional during student teaching. The attitudes of university methods instructors were evaluated as being not particularly progressive, but as more progressive than those of the students and cooperating teachers. Harrison concluded that the instructional and student teaching experiences are out of place and that perhaps the process needed rethinking.

Multiple Treatments

A number of studies compared an instructed group with an uninstructed group. Not surprisingly instructed group usually outperformed uninstructed group especially wher knowledge goals were involved. The studies summarized under this heading cover a variety of topics. Several dealt with topics related to inquiry. Zevin found that teachers could be trained to use inquiry methods. J. H. Wilson found that teachers trained to use inquiry materials used more analytical questions and encouraged pupil use of scientific procedures. D. E. Stone found that teachers could learn to use inductive teaching strategies. Caldwell found instructed teachers to spend more time coordinating learner activities. Two studies (Harris, and Breit and Butts) evaluated the effect of a single treatment on preservice and inservice populations.

Zevin (1970) studied the effectiveness of a summer institute to effect changes in teacher behavior toward an inquiry model of teaching. The model was derived from a survey of the relevant theoretical literature and was expressed in terms of a Flanders-like observation scheme. Pre-post institute observations of a sample of the participating teachers' classroom behaviors was taken. One group of 15 teachers received systematic inquiry training in addition to the other institite activities. A second group of institute teachers received no inquiry training. A third, matched group, received no inquiry or institute training. Significant changes in the desired direction were found for the group which received inquiry training. Younger, experienced teachers changed most readily; older, established lecture-recitation teachers changed the least. Zevin concluded that it is possible to train teachers in inquiry methods and that the inquiry methods will not be learned without specific training.

J. H. Wilson (1969) investigated the teaching procedures of two groups of elementary science teachers. One group received instruction in the Science Curriculum Improvement Study (SCIS), an inquiry-discovery approach. The other group received no instruction on a "new" approach. SCIS teachers were found to be more encouraging of observation, measurement, experimentation, data interpretation, and prediction.

SCIS teachers also used a higher proportion of analytic questions. Wilson concluded that the training program had effected teachers in the desired direction.

D. E. Stone (1969) discussed two groups of teachers, one of which attended an inservice training program to promote inductive teaching behaviors and the other which received no special training. The two groups were rated according to Flanders' system of interaction analysis. The experimental group showed greater change toward inductive styles of teaching. Both groups tended more toward inductive styles when special materials were used than with the regular lesson.

Caldwell (1969) reported an inservice methods course designed for elementary school teachers of science. An evaluation instrument was designed to measure the ratio between the amount of time spent in direct teaching activities (imparting knowledge) and time spent in indirect teaching activities (coordinating learning experiences). When compared with a control group which did not receive the inservice course, the experimental group was found to use indirect activities and laboratory experiences more often.

Six studies dealt with topics not related to inquiry. Kaya obtained evidence that teachers could learn to teach for cognitive process goals rather than goals reflecting content outcomes. Prentice had success in teaching teachers learning theory, and Zappo found an inservice program successful

in teaching teachers reading skills. Schmuck actually reports three different single treatment studies. One employed sensitivity training; a second, classroom visitations of consultants; and the third involved a faculty development laboratory. Positive, but different results were obtained for each study.

Kaya (1969) taught six teachers to incorporate cognitive functions into subject content curricula for the purpose of improving the cognitive functioning of pupils. The training program was conducted by the investigator and included 15 sessions. The central idea of the program was for teachers to acquire competence in expressing learning goals as cognitive processes rather than content outcomes. During the training period, teachers modified one unit as recommended by the investigator. A pre-post, matched groups design was used. The 246 pupils taught by the teachers in the experimental group were "matched" with an equal number of pupils of the same grade, subject, and assessed cognitive functioning. Cognitive functioning was assessed by the Kit of Reference Tests for Cognitive Factors (ETS, 1963). Three measures were taken to evaluate outcomes: Cognitive Factors, teacher-made subject-content and cognitive objectives tests, and standard achievement tests. As hypothesized pupils in the experimental group did significantly better on the teacher-made tests, even though teachers of control pupils agreed that the tests were "perfectly valid" for their pupils.

Also as hypothesized, experimental and control groups did equally well on the content oriented standardized achievement tests. Contrary to his hypothesis, experimentals did not exceed controls on the Cognitive Factors Tests for most comparisons. Teachers of experimentals that did better than controls continued to use the system after teaching the unit prepared during training which led Kaya to speculate that continued use might result in the hypothesized difference.

Prentice (1969) described a project designed to implement learning theory by training teachers in a 30-hour program. Classroom observation and achievement tests favored the trained teachers over a non-trained control group in changed instructional behavior and to some extent achievement of pupils.

Zappo (1969) tested the effectiveness of an inservice program on reading skills by comparing the achievement of pupils taught by teachers receiving the training with that of pupils taught by teachers not receiving inservice training in reading. The inservice program taught reading procedures consistent with Bruner's position on predisposition, structure, sequence, and reinforcement. Inservice teachers were instructed in these concepts and helped in the preparation of lesson plans employing these concepts. Six randomly selected teachers were assigned to the inservice and control groups. The program was conducted with seventh-grade pupils. Highly significant differences favoring the inservice group were found.

Schmack (1969) described three research projects which used various techniques for modifying teachers' classroom group processes. In the first was a teacher development laboratory which used sensitivity training and role playing in addition to discussion. The program fostered changes in classroom behavior to accompany changes in teachers' attitudes. The second program used consultants who visited classrooms and held individual and small group conferences. This program changed teachers' perceptions but not classroom behavior. The third project involved a faculty development laboratory which applied problem-solving techniques and group exercises and discussion to interpersonal relations. The third program was found to encourage the use of new group processes in the classroom.

Harris (1967) investigated the effects of demonstration teaching on inservice and preservice elementary teachers. He employed a number of "highly developed" demonstrations for the purpose of establishing their value in promoting teacher development. Data gathering involved a self-report inventory plus observations by trained observers of participants' classes. Harris found significant pre/post-treatment changes. He concluded that demonstrations are valuable in bringing about certain desired changes in teachers.

Breit and Butts (1969) compared the effectiveness of an experimental teacher education program with preservice and

inservice teachers. The program was designed to develop knowledge of the processes of science and change instructional decision behavior and was considered successful with both groups of teachers. Some differences were found between the two groups, particularly in the area of attitude changes.

Most of the studies summarized in this section employed a criterion of teacher behavior. Zevin, Wilson, Stone, Caldwell, Schmack, Harris, and Friet and Butts found that their treatments effected the behavior of teachers in a way favoring inquiry teaching or a related behavior.

Kaya, Prentice, and Zappo employed criteria involving learner achievement. Kaya found pupils of teachers consistently using cognitive process goals tended to do better on a cognitive factors test. Zevin found teachers to react to training differentially by age. The younger teachers in his sample acquired inquiry behaviors more readily than older teachers. Breit and Butts also found some differences by age-experience groups. Teachers, like pupils, are not exempt from the realities of differential responses to training. Prentice found some indication that teachers schooled in learning have pupils who learn more. Zappo found clear results in terms of pupil behavior for teachers schooled in reading skills. From these studies we can conclude that teachers can learn to behave in desired ways and that learned teacher behavior sometimes results in greater desired pupil learning.

Not only do teachers learn what they are caught, they seem to learn better when instruction is goal-directed and intense. Bunsen (1969) compared an intense and directed treatment, a less intense treatment, and a comparatively difused treatment with a no treatment control. The pupil criterion defined the goals for his study.

Bunsen described an inservice program in which Science--A Process Approach was taught to elementary school pupils by teachers classified into four groups: those who received workshop training and then taught inservice courses to other teachers; those taking the inservice course; those given training in a college elementary science methods course; and those with no special training. Pupils were tested on three AAAS Process Measures. It was found that pupils of the first group of teachers scored highest, while pupils of the fourth group scored the lowest.

The value of explicitly articulating content of related courses was demonstrated by Phillips (1968). He tested the hypothesis that elementary education students would learn arithmetic and methods better when taught simultaneously by a staff member qualified in both fields, than when each was taught separately as is generally the case. One third of the students were taught by the experimental method, the balance by the traditional method. Carefully designed instruments were used to assess operational skill, meaning and

understanding, and vocabulary. The experimental group significantly out performed the groups taught traditionally. In addition to advocating the combined approach to mathematics for elementary education students, Phillips called for placement of students in mathematics courses by demonstrated competence rather than by high school credits.

Taken together, three studies suggest the value of goal directed activity, especially when accompanied by a monitoring system. Both monitoring and goal setting were involved in the study reported by Jensen. Stanley's study involved monitoring only. Simon trained teachers in interaction analysis, which then became the goal, and used interaction analysis as a monitoring instrument.

Jensen (1969) compared the effectiveness of three self-evaluation procedures in changing teacher classroom behavior. Over a two-year period 65 elementary teachers received in-service training that included some combination of self-observation with video recordings. "Behavioral measures" and questionnaire data were gathered. Individual goal setting combined with video self-evaluations were found to effect moderate changes in teaching method and attitudes.

Stanley (1969) compared pupil achievement in classes whose teachers used a self-appraisal procedure to classes where no formal teacher self-appraisal occurred. The self-appraisal procedure used was A Guide to Self-Appraisal and

Development in Elementary Schools. The instrument was introduced as a part of a regular inservice program. Teachers were not told that a study was being conducted. Eight experimental and eight control classes were used, each group with approximately 250 pupils. The self-appraisal system was associated with significant differences as measured by end of the semester achievement tests.

Simon (1968) compared the effectiveness of behavior training and training in learning theory on the teaching behavior of two groups of 22 student teachers. Behavior training largely consisted of training in interaction analysis. Behavior training was associated with greater use of accepting behavior, less criticism of pupils, less teacher direction, more pupil-initiated talk, more extended pupil talk, and less silence or confusion. It was concluded that a maximum training effect could be obtained when students and their cooperating teachers are trained in interaction analysis.

The value of interaction analysis alone was questioned by Newport and McNeill (1970). They compared the teaching of a sample of elementary science teachers who had received training in the use of Science--A Process Approach (SAPA) materials with teachers who received training in interaction analysis (IA). A pre-post design was used. IA scores were used as the criterion. The subjects, who were drawn from a summer science workshop, were instructed to prepare a science

lesson using SAPA or text materials. Initial differences between the groups were found for only two of the 23 comparisons made. From an analysis of pretreatment data the investigators concluded that initially the teachers were either misusing the SAPA materials or that the materials evoked ordinary textbook teaching. Analysis of the posttreatment data produced a number of significant changes for the SAPA group but few for the IA group leading the investigators to conclude either that the teachers learned to select materials complementary to SAPA or that the teachers had changed their styles. Finally, Newport and McNeill concluded that the use of IA without accompanying instruction in the philosophy, content, and methods of a curriculum might be a questionable undertaking.

The last three studies in this subsection compared the effectiveness of two or more treatments in obtaining a single goal. The goal of Webb and Baird was course content; Pratzner and Hanson, content of a unit of instruction; and Ryan, a model of inquiry.

Webb and Baird (1967) compared differences in achievement scores of teacher education students taught by a lecture-discussion method and students taught by a "continuous progress" method. Students in the continuous progress group met twice as a class to learn procedural matters. Each was given a packet of materials that included learning objectives,

references, instructions, and worksheets. They were tested after the completion of each self-study unit. The continuous progress group was associated with higher post treatment achievement scores, especially for students with lower grade point averages.

Pratzner and Hanson (1969) compared the effectiveness of a teacher training unit presented two ways: as a lecture-discussion course and as film-group discussion. Teachers in the latter group performed better on the tests given, but not to a significant degree. It was concluded however that the film-discussion method appears to be more efficient and have economic advantages.

Ryan (1969) studied the effectiveness of an inservice training program in preparing elementary teachers to use an inquiry method when teaching social studies. A model of inquiry social studies teaching was derived from a review of theoretical literature and expressed as a Flanders-like observation instrument. By weighting various observation categories an "Inquiry Ratio" was derived. Three groups were used. One group received 15 hours of inservice inquiry training. A second group received an equal amount of instruction regarding materials which support an inquiry approach. A sample of non-participating teachers in the district was chosen as a control group. Observed differences by trained observers working with 20 minute video recordings of the

teacher sample significantly favored the inquiry training group. Ryan concluded that elementary teachers can be trained to use inquiry methods through short inservice programs.

Webb and Bair found for their experimental treatment, the continuous progress method, but noted differential effectiveness for ability levels. Pratzner and Hanson identified a trend, but not significance for their preferred method, film-group discussion. Ryan found that direct instruction in inquiry processes was superior to instruction in materials designed to promote inquiry, but this is rather like teaching for "A" and testing for "B".

Conclusion

Teachers learn what they are taught. They learn best when instruction is well defined, illustrated with films, telecasts, or demonstrations. Direct instruction in desired behaviors is more effective than instruction in related topics. Monitoring devices such as interaction analysis are valuable in helping teachers alter their behavior. Finally some methods are better for some teachers, but the realities of individual differences work with teachers as with pupils in the common schools.

Preparing Teachers of Teachers for the New Curricula

Most of the studies summarized in Part II dealt with inservice teacher education. This is not surprising in that much new material was included in the curricula which the teachers had to know if they were to teach the new curricula. A few dealt with preservice education and a still smaller number with both inservice and preservice. Obviously, the preservice education of teachers must be considered.

The studies summarized in this last section of Part II deal with the inservice education of the teachers of teachers. Tucker identified a basic problem of preservice education for the social studies which perhaps might be shared by the other areas. The problem was that teacher educators and curriculum developers often have different and conflicting goals. Such a situation cannot help but create dissonance in beginning teachers.

Tucker (1971) surveyed a geographically stratified sample of social studies educators who were members of the NCSS during 1969 to determine their attitudes toward the new social studies (NSS). She found that social studies educators (SSE) regarded NSS as being "overly academic, cerebral, and teacher centered. They wanted more emphasis on student interests, community activities, social action, and the affective domain." SSE who held their appointments in academic departments were less critical of NSS. It was also felt that teachers

should assume greater responsibility of developing curriculum. Tucker examined three hypotheses that might explain her findings. First, she found support for a hypothesis that NSS required competencies probably not held by educators who were largely prepared in education or history. Second, she found some support for the notion that splitting of curriculum development from methods was resented by SSE. Finally, she hypothesized a fundamental value conflict between NSS and the SSE as indicated by their perceptions of the new curricula. Tucker found the last explanations most persuasive.

A conference of curriculum developers of new social studies was sponsored by the Social Science Education Consortium and was described by Fox, Lippett, Giraulf, and Schaible (1967). The purpose of the two day meeting was to explore problems that prevented teachers from properly using new social studies materials. Since a common concern of these materials was a stress on inquiry the conference was organized to promote inquiry. Specifically a task-oriented group process approach was used. The group tasks were selected to bring out the problems the curriculum developers were having. A number of problems were identified, some of which were held in common by curriculum developers and teachers and some separately. In confronting the problems of installing a developed curriculum into an ongoing instructional situation the linear curriculum development model was brought into question.

Rather than being the recipients of finished curricula conceived by scholars and prepared by distant specialists it was suggested that teachers should occupy a core position during the entire process. By being involved at all stages of development it was hoped teachers would understand the materials better and be prepared to make the many adjustments reuqired during any period of implementation. There was some indication that curriculum developers were not totally understanding of the problems teachers faced in carrying out curriculum innovation.

A second problem relates to the content preparation of teachers. As was noted in the previous subsection Phillips found it effective to teach mathematics for elementary teachers in combination with mathematics methods. Iauna and Josephs noted the importance of teachers learning English content in a manner complimentary to the way they would be expected to teach it. If this were to be done considerable retraining of the teachers of teachers would be required.

Iauna and Josephs (1964) held that it was important for teachers to learn English in a manner compatible with the way it should be taught in the common schools. They called for an "inductive, cumulative and interrelated program in the language arts" for future teachers in English (p. 178). They also called for summer institutes and inservice programs to retrain practicing teachers.

Inservice training of teachers of teachers was the focus of three studies. Merkle (1970) reported an inservice program for science consultants and science educators in Science--A Process Approach and Science Improvement Study curricula. The goal of the workshop was to promote change in teacher education compatible with the goals of the above curricula. The reactions of participants to the workshop and certain behavior changes were used to evaluate the workshop. Significant differences in knowledge of the programs, knowledge of group processes, knowledge of change agent skills, and attitudes were found. A key criterion was the activities of participants upon return to their home campuses. Increases in services rendered having goals compatible with the two curricula and alterations in content of methods and sciences were accepted as positive data. Similar approaches were used by Rowe and Girault.

Rowe (1971) studied certain activities of ten teams of educators which participated in a three week leadership training program at Columbia University. The purpose of the training was to encourage changes in the teaching of science and science methods complementary to two courses: the Science Curriculum Improvement Study (SCIS) and Science--A Process Approach (SAPA). The strategy employed was to create institutional teams of scientists and science educators because the role of academic innovator was seen as punishing.

It was felt that the moral support afforded by a partner on the other side of the academic street would help trainees persist despite well established institutional rigidities. A series of training laboratory and microteaching experiences was conducted during June of 1968. Success of the program was judged in terms of the number of laboratory exercises and techniques employed and the number of innovations made by participant teams in the two and one-half years following the training program. Rowe found that participants took actions that resulted in 37,575 children in 1537 classrooms being engaged in SCIS and SAPA instruction. Six institutions adjusted their science for non-majors to include some SCIS or SAPA relevant content. Five institutions modified education courses to reflect SCIS and SAPA content and processes. Program participants visited many classrooms and gave numerous speeches to PTA's and similar organizations. Both of these activities had been rare events prior to training. Finally, eleven NSF or CCSS training grants were obtained by program alumni; five unsuccessful attempts were made. Rowe felt the training program was highly successful as judged by the innovative activities its participants exhibited after leadership training.

Girault (1971) reported an applied behavioral science training program designed "to aid directors of NSF Resource Personnel Workshops in the design and management of more

effective learning environments." Project directors and one or more institute staff members met in April of 1968 for a two and one-half day workshop. The workshop included a number of experiences designed to increase participant knowledge of and skill in interaction processes. The workshop produced generally positive results as indicated by the number of workshop activities incorporated into institutes during the following summer. Several classes of criticism occurred including: lateness of workshop prevented incorporation of learnings, confusion over terms used by scientists and social sciences, and general ignorance of each of the other's purposes and procedures. A follow-up session was held which helped identify problems which were largely overcome during another workshop the following spring.

The following studies deal with the preparation of teachers for inservice education. They have in common some use of a multiplier effect. That is, a small group teaches a larger group which in turn is expected to teach an even larger group. For example the Education Development Center Model School in Washington D. C. provided inservice experiences in teaching, content, and curriculum for several years and then hit upon the notion of the "innovation teams." Innovation teams were made up of teachers who had significant experience with and interest in the project. Through T-group experiences these teachers developed a group cohesiveness that enabled them to design and conduct workshops on their own.

Three such programs were conducted in mathematics. Izzo and Izzo reported one designed to aid elementary teachers, supervisors, and administrators. Edwards and Hammond, and Mueller reported similar programs. Kleinman reported a program that enlisted high school teachers in the process of changing elementary education.

Izzo and Izzo (1964) conducted a six-week summer institute of 31 elementary school teachers, supervisors, and administrators. The institute was designed to acquaint participants with basic concepts required to teach the new mathematics meaningfully. All participants had agreed upon accepting their fellowships to conduct inservice workshops in their home districts upon return. In all, 23 workshops were conducted. The workshops prepared over 800 teachers to teach the new math to 2800 pupils. Administrators of districts having inservice workshops and participating teachers were "enthusiastic" about the program.

Edwards and Hammond (1966) described an institute program conducted at Morgan State College in Baltimore. The program was built on the recommendations of the undergraduate program in mathematics of the Mathematics Association of America. The course described was one of two recommended courses in number theory. The described course made extensive use of number lines and objects. Participants were expected to conduct inservice workshops upon completion of the program.

Mueller (1970) described the Maryland Elementary Mathematics In-Service Program (MEMIP). The program sought to teach arithmetic algorithms using games and physical objects. Hierarchies of behavioral objectives were stressed. Generally teachers were able to demonstrate the steps in using an algorithm, to justify an algorithm using game rules, and to construct physical explanations of algorithms. A multiplier model was employed. MEMIP trained state inservice leaders who in turn conducted programs throughout the state of Maryland. No evaluative data were presented.

Kleinman (1966) described an inservice program built on the "multiplier model." In this case the multiplier effect was obtained by having a science educator work with a small group of high school teachers to plan an inservice program in science for elementary school teachers. Six physical science and six natural science teachers and 100 elementary teachers were involved. The two semester program was conducted at high schools around Rutgers. Physical science was taught in the first semester; natural science in the spring. The course carried graduate credit. A basic problem hinged on Kleinmen's desire to have the courses taught in a way as to model science inquiry and a perceived need to cover a lot of science since the participating teachers were poorly prepared in science. She compromised in favor of an inquiry approach. The actual science taught was at the junior high

school level. A number of problems were encountered stemming from the elementary teachers' lack of confidence in science. Kleinman concluded that the need for inservice programs was great and that elementary teachers were willing to work hard. She also noted the importance of selling such programs.

Little can be concluded from these studies. The workshops of the sort reported by Rowe and Gerault seem to have produced results. The post-workshop activities of the participants were monitored and complementary activities were reported. Apparently these behavior oriented workshops had a positive effect on the participants.

The effects of the several reports clustered under the label multiplier model are less well documented. We only know that the programs were conducted. In no case was any data presented to document the effect on other teachers or learners of the training received in these programs. But then, teacher education has operated in a data vacuum for decades; these investigators at least reported their programs.

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